Using communication technologies to deliver public health agendas in National Health Service food and drink automated vending

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Student Declaration

The author of this thesis, Lucy Zarina Campbell, confirms that the work presented in this thesis is her own. Where information has been derived from other sources, the author confirms that this has been indicated in the thesis.

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Abstract

This research responded to a National Health Service (NHS) wide problem. The problem is how to create healthier automated food and drink vending services. The research's' interpretation of this central research problem is embedded in the Facilities Management (FM) perspective.

Vending retail products do not support government healthy lifestyle policies and initiatives. FMs have to change this through catering contracts. However, there is little guidance on how to design, evidence and operationalise improvement.

The research tested vending point of sale designs over a year, trying to reduce the sale of unhealthy products. Secondly, it developed a novel application of a nutritional profile to enable the service design process and evidence change. Thirdly, the research baselined service level information through survey n=1,292. Night shift staff were a key stakeholder as it was thought that vending was their only retail catering and the impact was unknown.

Regression modelling and multivariate analysis was used in the survey and design tests. Linear regression was used to understand the impact of vending point of sale design on sales. Logistic regression was used to test service level perceptions in the survey. The statistical methods used were flexible. The survey design and analysis is widely applicable to evaluate many services.

The research found that in combination, changing product ranges, adding nutritional labels, and moving water to eye level significantly reduces unhealthy sales. However real change requires healthier vending products. The nutritional profile adapted is highly suitable to standardise service and evaluate how healthy vending products really are.

The survey was a novel and statistically robust addition to FM service evaluation. It proved staff perception of poor catering, inadequate breaks, innutritious food and need for staff food education. Vending was central. Finally, making meaningful service improvements and setting thresholds in the statistical models confidently required in depth first-hand knowledge.

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Chapter 1 Introduction

1.1 Introduction

The pillars that form the context of this research are facilities management (FM) services, snack and drink automated vending technologies, public health, and government policy. These pillars are part of the same system of communication and this system will be explored and influenced in this research in key areas, in order to understand how to deliver public health agendas in National Health Service (NHS) food and drink automated vending.

Charles West Churchman, an early system thinking researcher, outlined the overarching considerations of studying a system such as healthier automated food and drink vending services, allowing one to consider it a design problem (Churchman 1971). He describes a wicked problem, a 'Class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole items are thoroughly confusing and further, where "solutions" often turn out to be worse than the symptoms' (Churchman 1967, Rittel and Webber 1973).

This statement candidly summarises the complexities of researching a communication system such as public health agendas in NHS snack and drink vending. 'Conflicting values' in this research are many. Improving diets is inextricably linked to the economic drivers of a cost-effective and profitable retail service such as vending, as well as numerous financial incentives for change. There are legal constraints, compliance issues and government policy agendas. There are also underlying values to do with improving people's long term health and reducing the cost of treating preventable illnesses in the NHS, as well ass the potential increased productivity of a thriving and innovative infrastructure for people to work in (DECC 2012, World Resources SIM Centre 2002, BIFM 2013, Hodges 2002, Marmot 2010). This level of complexity cannot be accounted for by traditional approaches to public administration, which rely on linear rational models (Oborn et al 2011).

Given that conflicting values exist this research must ask; how can they be addressed in vending service improvements so that none create a negative impact on the others? The key issue is about aligning values of different groups invested in vending services to create an overall positive and tangible outcome. It may remain impossible to prove an outcome 'true' or 'false'. Communication creates the hinge upon which these issues balance.

Churchman also draws attention to confusing information. Measures of public health, health care costs, policy and catering procurement (all involved in vending services in the NHS) allude to different data sets with varying degrees of supply chain transparency inherent. The volume of information being gathered, given the wide range of service agendas, needs to reflect government policy change towards healthier diets and disparate or ill-defined measures of success. Variations in methods of correlation and analysis must be attuned to disparate agendas (Gase et al 2011).

The ideal balance within this system is that by serving nutritious food and drink, specifically at the research site at Barts Health NHS Trust, it will help reduce preventable long-term illnesses caused by poor diet and help to maintain a nourished and engaged workforce (NHS 2014, Marmot 2010). It is also hoped that it can serve the economic drivers of a cost-effective and profitable retail service, meet the legal constraints that are linked to compliance, reduce the risks of the increased financial burden of treating long-term illness, improve alignment with government policy and increase productivity, creating a thriving and innovative infrastructure

for people to work in, and to support healthy lifestyles (DECC 2012, Rodriguez et al 2002, BIFM 2013, Hodges 2002).

The diagram below reimagines the system being interrogated and influenced in this research as a set of elements, each rooted in communication that can help make improvements.

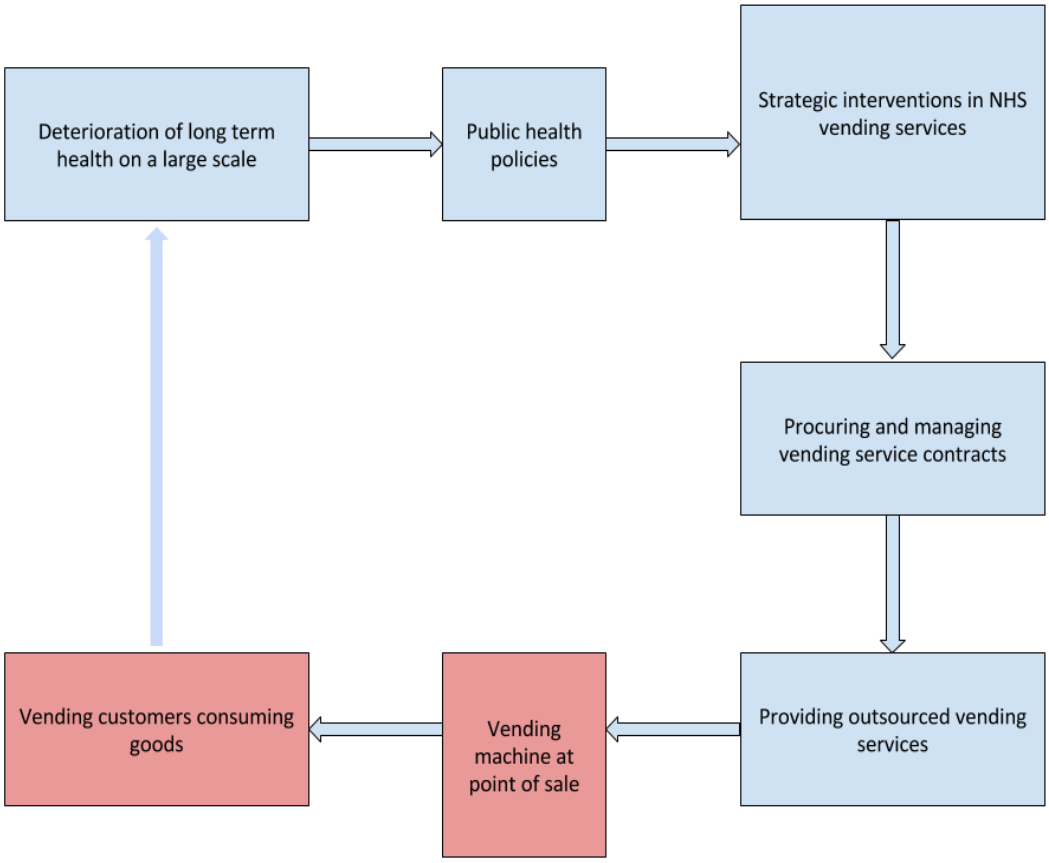


Figure 1 Diagram of vending service improvement opportunities

The first square in the top left corner is the symptom of the root cause of the problem. The assumption of this research is that at best, in a highly visible service like vending, the image of chocolates and crisps does not support the ideals of healthcare or long term health, and seeing staff and members of the public buying and eating unhealthy food from retail outlets on NHS sites sets a poor example. It is similar to seeing nurses, patients and visitors smoking or drinking alcohol on the premises, while treating liver failure and lung cancer.

The following squares each relate to documents or physical situations where communication can help improve vending services. The second square references the central government policy and strategy for change in the NHS, all part of the NHS Five Year Forward View Report (NHS England 2014). This strategic policy document sets forth ways that the NHS was preventing long-term preventable illness at the time. The 5yfv report sets forth agendas for a sustainable model of healthcare and poor lifestyle choices are a focal concern within it. The major influencers of poor lifestyle choices are identified in the report as poor diet, smoking and alcohol consumption.

After the first two squares, the problem space becomes ill or undefined. It is in relation to this system of communication that FM services, snack and drink vending technologies, end users, service environments must all change to align with government policy and attitudes to public health. This thesis will address these areas throughout and consider each as a communication

design problem, either rewriting strategies, testing industry leading point of sale designs, communicating directly with service users, or writing new and more effective measures into contracts. These can all be considered communication design problems.

1.2 Research objectives

The primary research focused on the latter elements of the diagram above, given that the first two are already well established through the Five Year Forwards View and the government's focus on preventative care by the time FMs take an active role (NHS England 2014). Scientific knowledge is explored and it will be grouped and applied to improve the latter elements of communication, working from NHS FM vending services perspective towards more effective delivery of public health policy.

Specifically, the primary research objective was to test a communication and product placement approach designed to encourage customers to purchase healthier alternatives from vending machines where their purchases were unsupervised. The measure was sales data, applying statistical tests to an experiment that followed deductive research approach. The second objective was to take a survey based research approach to understand user perceptions of the provision of vending services within hospital facilities. Statistical methods were used to analyse a targeted portion of a wider catering survey that was undertaken to contribute to an overall drive for catering service improvement.

As well as the two primary research activities, communication design areas being actively explored included policy, strategy, supply chain, service contracting, point of sale, and end service user engagement. This exploratory portion of the research enabled holistic consideration of how the two pieces of primary research could best be designed and executed to contribute to the overall need for catering service improvement, with the unhealthy product sold in vending services at the heart of challenges. This exploratory, ground up research constitutes the majority of the contents of the literature review.

Not all the activities carried out in this research project were developed through formalised appropriations and applications of scientific knowledge. They will, however, be reflected throughout this document as a way to frame the review and discussion of relevant research that could enable service improvement. Projects were taken on by the researcher to support wider developments in catering improvement, and this grounded approach was the framework of the literature review and combined with the literature review formed the basis of the primary research design decisions. It was felt that this grounded approach to creating the primary research, with continual reflection upon its' usefulness, applicability in context, and impact on services in the NHS, was a key strength in the project that gave confidence to the decision making.

The first piece of primary research was focused on the point of sale and purchasing environment. The research objective was to design and test current intervention methods that might encourage healthier product choices. The aim was to gather point of sale information, including product sales, and use it to quantitatively test leading policy approaches that encourage healthier eating and healthier choices in NHS vending services.

Point of sale hypothesis

The main hypothesis in this experiment was that planned communication-based interventions using different technologies to change the point of sale vending machine environment can influence users to make healthier choices. The null hypothesis was that the interventions make no difference.

Staff survey research problem

The second piece of primary research was to do with end service user engagement. The research hypothesis was that aspects of the current catering provision were unsatisfactory to staff in meeting their nutritional needs, especially on night shifts. The null hypothesis was that staff were satisfied and reported their nutritional needs were being met.

The survey was designed to understand user perceptions and satisfaction with service by conducting a large-scale catering survey. Quantitatively analysing satisfaction levels would allow one to inform internal catering strategies.

The contextual work surrounding tasks, and the literature review, allowed the primary research to gain impact and validity, and to make methodological choices. There was no point testing an option that could not them be adopted into service design. Vending services were viewed in the wider context of retail and catering, focusing on management practice and the research allowed for understanding and meaningful reflection on measures that could be used and have impact at this broad level.

1.3 Research design context

The primary research design focuses on end service users of vending services. It continuously reflected on how the knowledge created could then move back towards policy analysis and review key communication. This also meant taking insights from high level government communication documents and using them in the design of the primary research and informing the intended outcomes. It was the first-hand experience of the researcher that brought these elements together, and this merging of different sources of knowledge is often described as a mixed methods approach. It was not possible to formalise the latter first hand elements of the research project, simply due to restrictions of the scope of the project. It was, however, possible to reflect on what the findings of the user-focused research implied for the areas of policy, supply chain and contract information. The focus on end service users was significant and reflected the industry focus. End service change was viewed as an easier, less controlled or resource-heavy area of work than, for example, changing contracts or directly challenging policy. There has also been an explicit call for more understanding of how to influence user choices in vending interventions, as well as a call for more understanding of how to influence vending choices in healthcare settings specifically, which drove the research focus (Skov et al 2013, Hua and Ickovics 2016). A final reason behind the research focus is that it creates an evidence-based, user-centred approach to service change discussions that might inform service design. This bottom-up approach is especially vital in FM, which exists solely due to end service user needs and is bound to operational conflicts and problem solving in real time.

Moving through the problem space and using communication as the guiding principal to inform the research agendas, from service use to service design, this research required both qualitative and quantitative instruments throughout, using a mixed methods design to bring them together (Creswell 2013, Ritchie et al 2013 p39-47, Tashakori and Teddlie 2010, Morgan 2007). 1.4 Health context

The first element in Figure 1 addresses the deterioration of long-term health on a large scale, one of the biggest healthcare challenges in the UK and across the developed world (NHS England 2014). One of the central causes of a deterioration of long-term health is the poor lifestyle choices people make. Diet is one part of this and, combined with the other lifestyle of choices of smoking, lack of exercise and alcohol consumption, it forms the focus of government concern over long-term health (Opie 2011, Marmot 2010). Naturally, the health problems resulting from poor diet are tied into a poor lifestyle where diet is only one, if a very important element. It is up to FMs to take this focus and translate it into service design.

There is good cause for concern over people's diet, given that it can, largely through the development of obesity, lead to diabetes (type 2), cardiovascular disease, joint pain, respiratory problems, sores, mobility issues, risk of heart attack, early mortality, hypertension, stroke, cancer, and psychological problems (Björntorp 2001 p. 485–510).

Vending machines, and the kinds of products sold in vending machines such as confectionary, salted snacks and sugary drinks, have been linked through numerous pieces of research with the kind of poor diet that causes such illnesses (Ermetici et al 2016, Kelly et al 2012, Maliderou et al 2006, O'Hare 2015, Almeida et al 2014, Gemmil and Cotugna 2005, Capacci et. al. 2012, Chauliac and Hercberg 2012, Mesas et. al. 2012, Muñoz-Pareja et. al. 2013, Martin and Chauliac 2014). Connecting vending to diet and lifestyle-created health concerns, research in Spain, accounting for over 11,000 individuals over a two-year period classed vending purchases as an obesity-related eating behavior (OREB), and found links between the presence of vending and higher energy intake, consumption of sugary drinks and even alcohol consumption, as well as the likelihood of obesity (Mesas et. al. 2012, Muñoz-Pareja et. al. 2013). The limited kinds of products sold, and the way they are sold – automatically, with optimal convenience and availability – all are likely factors as to why vending machines contribute to poor lifestyle choices.

Vending machine prices are often greatly inflated, however this does not seem to deter consumption. The presence of vending machines in lower socioeconomic areas, particularly in urban locations, has been shown to be a predictor of poor dental health among children living in inner city London and obesity in low income children in the USA (Maliderou et al 2006, O'hara and Haynes-Maslow 2015).

This chapter will begin by discussing the ingredients and products in vending machines and their impact upon health, and then move on to consider vending technology as an enabler of poor dietary decisions in the section on 'vending technologies in context'. Both have a different role to play in the system of communication that might be used to create improvements, both are important ellements in the underlying problems.

The main ingredients of vending products linked to poor health are fat, saturated fat, sugar and salt. This opening discussion is concerned with some of the negative health impacts of over consumption of these ingredients. Firstly, sugar is linked to dental disease, obesity, both type 2 diabetes and heart disease (NHS 2015). Secondly, fat, in the form of trans fatty acid, is one of the main culprits associated with severe health complications (NHS 2015). In contrast to this type of fat, fat associated with a Mediterranean diet, such as oils extracted from nuts, fish and olives, have been strongly linked with positive health outcomes (Hoffman and Gerber 2012).

Thirdly, salt, which consumed in high proportion and sustained over the recommended levels, has been linked to high blood pressure, heart failure, kidney problems and kidney stones, oedema (fluid retention), stroke, stomach cancer, left ventricular hypertrophy (thickening of heart muscle), osteoporosis, and increased risk of fracture (State Government of Victoria 2015,

Kristy 2014, Goldstein and Leshem 2014, Nutrition Australia 2015, Medline Plus 2015, FSA 2014, WHO 2015, CDC 2012).

Overconsumption of sugar and fat are also especially linked to weight gain over time, leading to a chronic positive energy balance – what is commonly known as obesity (Weise et al 2014 NHS 2015). Obesity comes with its own potentially lethal health complications, both to the internal organs and the musculoskeletal system, and is most commonly linked with heart disease (EUFIC 2015, State Government of Victoria 2015, Nutrition Australia 2015, Medlineplus 2015, FSA 2014, WHO 2015, CDC 2012, Zock 2006). In the UK, obesity is a common marker for public health linked with poor diet and lifestyle. In England, for example, government reports show that 24% of women and 26% of men are obese (Barts 2016). As with the UK, the main public health aim in many developed countries has become the prevention of chronic (metabolic) diseases associated with obesity (EUFIC 2015).

While obesity is a widespread indication of poor diet and lifestyle, it is important to consider malnutrition or 'undernutrition' as well, as this is also a problem across the UK caused by poor diet (Barts 2016). One can, in fact, be malnourished and obese at the same time.

Poor long-term health also has several associated negative costs and healthcare costs created, in part or wholly, by diet are causing concern for the UK government. 'To take just one example, Diabetes UK estimate that the NHS is already spending about £10 billion a year on diabetes', and type 2 diabetes is strongly linked with poor diet and lifestyle (NHS 2014). For 2015/16, the overall NHS budget was around £116.4 billion so this represents a significant proportion of the overall spend (NHS 2016).

The health concerns linked to the kinds of confectionary products sold in automated food and drink vending machines raises a moral question as to whether vending should be available in a hospital (Kibblewhite et al 2010; Norton 2014). It also raises a reputational question as to whether the NHS can be seen to sell and support consumption of these products. Given that vending machines are not banned in the UK, and neither are the products commonly sold in them, the negative effects of poor lifestyle choices are a concern for NHS Trusts like Barts Health NHS Trust (Barts Health). The NHS protect and care for public health and yet many hospitals have vending in every building and use it as the sole means to provide out-of-hours catering for staff. It is these concerns and conflict, and the widespread use of vending which gave rise to this research. NHS Trusts are dedicated to looking after and saving lives but they sell unhealthy food and this reflects a deep moral dilemma in the way service is provided in the NHS. In vending in particular, there was a widespread lack of understanding over how best to proceed in service improvements at the time this project began.

1.4 Regional demographics of Barts Health

Poor lifestyle choices are a particular problem in low income areas including Barts Health constituencies. Barts Health hospitals are situated in the boroughs of Newham, Tower Hamlets, Waltham Forest and the City of London. The Trust has its own unique demographic, with especially high concerns over the health risks of a poor diet and unhealthy lifestyle in these low-income areas. In Barts Health constituencies, deprivation is higher than the average across England (save the City of London) and this is a precursor for the kinds of diseases strongly associated with poor lifestyle choices (PHE 2012).

According to the 2015 Health Profiles from Public Health England (PHE), the local incidence of diabetes is above the national average for Barts Health, as is mortality in those under 75 years from both cardiovascular disease and cancer (PHE 2015). Adult obesity levels in 2012 were

below the average in England but remain a significant health risk both locally and nationally (Barts 2016).

The levels of childhood obesity for Barts Health were found to be significantly worse than the national average, highlighting the risks to future health (Barts 2016). Linking these concerns back to vending, the presence of vending machines in lower socioeconomic areas, particularly in urban locations, has been shown to be a predictor of poor dental health among children living in inner city London and obesity in low income children in the USA (Maliderou et al 2006, O'hara and Haynes-Maslow 2015). For Barts Health, with a low income-dominated demographic, promoting healthy lifestyles is especially important and the trend of childhood obesity suggests that it will become a greater problem in the future.

Making a change to Barts Health vending would have a wide-reaching effect as it is the largest UK NHS Trust. Figures from 2012 showed that Barts Health 'saw 1.3 million outpatients, cared for 420,000 emergency patients, delivered over 15,000 babies, undertook over 213,000 diagnostic tests and performed over 53,000 operations' as well as treating over 260,000 inpatients (Barts 2014). The number of staff at the Trust is currently just under 16,000. Given that there are vending machines in a high proportion of the waiting rooms, cafes, staff rooms and other public spaces across the entire Trust, and that they serve this large population under a high-value contract, the scale of the potential impact of this research in making vending service improvements is significant.

1.5 Policy context

The second point in Figure 1 signposts to the approach the government takes to preventing long-term illness. This is a key concern for the NHS and is reflected in policy, with guidance strongly geared towards reducing salt, fat, saturated fat, and sugar. Just like alcohol, and the many toxic ingredients found in tobacco smoke, these ingredients are over-consumed by the population and create grave concerns for public health. The World Health Organisation (WHO) has also demonstrated their support for dietary changes, asking governments to encourage consumer demand for healthy foods and meals, and to coordinate trade, food and agricultural policies with the protection and promotion of public health (WHO 2015).

The 5yfv report covers many different areas of healthcare services. Specific to this research, it explains that Public Health England (PHE) 'Will actively support comprehensive, hard-hitting and broad-based national action (for the improvement of food and drink services), to include clear information and labelling, targeted personal support and wider changes to distribution, marketing, pricing, and product formulation. We will also use the substantial combined purchasing power of the NHS to reinforce these measures' (NHS England 2014). It advises to cut access to unhealthy products, implement food standards and provide healthy options for night staff for improved staff health and well-being (NHS England 2014).

There is increasing drive to govern catering services in the NHS in light of this policy and, within this development, there has been scrutiny over how vending machines fit into a public health message for NHS staff and visitors, and how NHS Trusts can deliver strategic vision for their catering services (HFSP 2014). Vending is a key area of focus as it is the sole retail outlet for staff for significant periods of operational time, and sells some of the least nutritious products available. This is at odds with the NHS drive for sustainable care and long-term health.

Due to policy focus on preventative care and creating a healthy culture in the NHS, there was a £1.5m financial incentive available for Trusts like Barts Health to make improvements to food and drink sold on hospital premises as part of the new Commissioning for Quality and Innovation

4 (CQUIN) (DoH 2014). CQUIN is a payment framework that enables commissioners to reward excellence by linking a proportion of English healthcare providers' income to the achievement of local quality improvement goals such as those associated with public health agendas.

To be awarded this funding, Trusts must demonstrate to the Department of Health (DoH) that less healthy food and drink was being restricted, and healthier choices promoted in non-patient food like retail and vending (DoH 2014). The incentive is also given based on the Trust's ability to gather baseline data about providers for the DoH (DoH 2014). Potential additional financial support to change service delivery is a universally critical motivation for facilities managers (FMs), who are under continuous pressure to deliver cost-efficient and commercially attractive services (Prodgers 2009; Davies 2011; Hall 96; Mclennan 2004; Coenen and von Felton 2014).

Focus on staff

Vending service improvement is largely for the benefit of the nearly 16,000 members of staff at Barts Health. Three quarters of hospitals in the NHS do not offer healthy food to staff working night shifts, when often vending is the only available retail outlet (NHS England 2014). Better nourished staff can also provide better care and work more efficiently, improving the overall efficiency of the NHS, clinical care, financial performance and levels of patient mortality (West and Dawson 2012 in Kings Fund 2015; Marmot 2010, NHS England 2014). It has previously been estimated the NHS could reduce its overall sickness rate by a third – the equivalent of adding almost 15,000 staff and 3.3 million working days at a cost saving of £550m, by improving the health and well-being of staff (NHS England 2014). Improvements in staff diets might even influence friends and families of staff too (Marmot 2010).

The role of vending in poor lifestyles and the links to work performance and public health is widely acknowledged, and vending is especially influential in determining eating behaviours where there is a captive audience (Kelly et al 2012, Apostolopoulos et al 2011, Escoto et al 2010). This includes those working long, unsociable hours and exposed most frequently to the poor nutritional quality of the products presented in vending machines. Many members of staff in the NHS working in 24-hour wards fit this description well. There is also concern at Barts Health that staff have little time to take proper breaks. This was the focus of the staff survey.

Finally, in addition to staff, vending services also impact visitors and patients, and patients can be gravely affected by consuming the products sold in vending machines at certain stages in their treatment. This is especially true in renal, where one of the busiest vending machines at one Barts Health site was situated.

It can, therefore, be seen that improving vending services, which are often in the most highly visible areas of the hospital, might positively impact patients, staff and visitors, as well as the culture of the healthcare environment and the reputation of Barts Health as a health care provider. The impact that FM services have on these wider issues is significant, even though service management may not reflect this wider picture, it could. There might, this research would argue, be a way to use service measures and performance evaluations of vending services to factor in user behaviours such as night shift requirements.

1.6 Putting policy into practice

Although there is widespread acknowledgement that long term health is a concern and diet is a vital contributing factor, it is unclear how public health agendas in retail catering and prevention of long-term illnesses through better lifestyle choices could be represented in the design and delivery of vending services at Barts Health. Little was known at the start of the project about how to improve vending based on the overall assertions made by reports such as the 5yfv.

There was work done historically at Barts Health that touches on the policy issues being raised. For example, the Trust commissioned the Marmot report in 2010. It focuses on staff health and well-being which is appropriate given that they represent the largest consumer of retail catering such as vending. Staff are, therefore, recognised by the UK government and at Barts Health as a critical group who should be encouraged to adopt healthier lifestyles during their time working in healthcare facilities (DoH 2014, Marmot 2010).

The report focuses on the positive impact of improving retail catering and staff diet. One of the overarching pieces of advice in the report is to focus on the role of communication as a way to make improvements across services. It also specifically advises healthier food and less unhealthy food be made available by the Trust similar to the CQUIN 4 agenda. It goes into more detail, with mention of the use of traffic light food labels in vending machines alongside other specific actions such as food and weight loss education programs, and improved nutritional value of food (Marmot 2010). The Marmot report was published before much of the new government policy but remains relevant today, and has since been reinforced on a national level with the publication of the 5yfv.

FM leaders in the estates and facilities department at Barts Health supported this EngD research project, driven by the significant opportunities to improve staff diet which still remains through the improvement of retail catering and vending which were described in the Marmot report but never tested in vending services.

Another key motivator was that, at the time of this research, changes in catering were imminent as the contract was being retendered. This period of change created an opportunity to deliver a rigorous investigation, to test and to intervene to create system-wide improvements. The retender was part of a large-scale change for the Trust with all soft FM services being renewed under one contract, including cleaning, security and parking. The contract has a reported value of £600m over ten years (FMJ 2016). In the past, vending had been part of this package but retail was being split off into a separate contract for the first time. With policy changes and an increase in scrutiny occurring simultaneously, this change over presented a significant opportunity for vending service improvement.

Using the Barts Health estates team as the basis of the research perspective provided much needed, and pragmatic boundaries to the research. This research explored the potential for service improvement and delivery of public health policies throughout vending services within the scope of the in-house FM function at Barts Health, current vending service provision, and the available guidance and research. The research behind policy advice was explored, and some of it tested, to find supporting methods and contemporary approaches that were potentially well-suited to application in this unique context. Policy changes and the upcoming tender were both major developments which resulted in high-level support from the Trust and the estates team. This created a unique opportunity for this research to have significant impact.

One experience which sums up this support, and also reveals the challenges faced by similar efforts, occurred during a meeting as a representative for Barts Health in the Department for Environment, Food & Rural Affairs (DEFRA) Government Buying Standards (GBS) working group.

The position of Barts Health representative on the DEFRA working group was given to this researcher by the industrial supervisor of this research project and environmental manager at Barts Health. It was an ongoing role throughout the research project. It was an opportunity to sit and discuss ideas at a table with representatives from across the public sector, including from DEFRA, the judicial system, immigration, the education sector and the NHS.

The challenge revealed in these meetings with DEFRA was that government efforts and policies are continuously and cyclically presented to public sector organisations but are not embedded which creates fatigue among public sector organisations. Two representatives from another large scale public sector organisation expressed their frustration that the focus on government buying standards was a repetition of prior efforts and we were 'rehashing' a similar process undertaken fifteen years earlier. To someone relatively new to government policy it revealed the frequent repetition of government policy and the frustration created when it is not fully implemented.

More subtle lessons from this experience emerged too, specifically that policy makers might struggle to collate and apply experiences more widely and that vending services must be capable of dealing with recurring and changing political agendas, yet maintain the core values of public health at its centre. For example, in previous generations the idea of reducing fat intake would have been completely at odds with public health, when the focus was ensuring people were not too far underweight or even starving.

Using communication as a core focus in this research meant that the effective capture and communication of information remained central as a means of meeting the challenge of changing policy landscapes. Communication was viewed as a balancer of a flexible system that reassesses and absorbs change. Service improvement itself is justifiably a continuous improvement process, given that it is time-dependent, part mechanical and material, and part conceptual (Fitzimmons and Fitzimmons 2011). The comment made during the DEFRA meeting also highlighted the importance of connecting organisations together to share insights gained, which, with appropriate, context-specific testing and corroboration, could lead to improved practices.

1.7 Vending technologies context

The UK automated food and drink vending sector, like many countries both developing and developed, is now substantial. There are approximately 462,700 machines vending around 6bn snack and drink products per year in the UK (Vogue 2016). The ratio of machines to people is 1:139 in the UK, and is even higher in other countries. For example, 1:23 in Japan and 1:55 in the USA (Automatic Vending Association 2016). The UK vending machine industry employs over 15,000 people and turns over approximately £1.65bn per year, while the European turnover is € 11.8bn (European Vending Association 2016).

Vending contradicts traditional retail technologies for a number of reasons. A vending machine can be stored easily, tightly controlled, and counted as a tangible asset that one can own and resource (Van Looy et al 2003 p10-11). Secondly, it replaces the need for a person to manage each retail outlet, often with low stock rotation requirements and products with long expiry dates, saving money on personnel, especially in countries where labour costs are considered high. Thirdly, vending services are, at point of sale, mechanical and material yet able to appeal to the customer's emotions through marketing and advertising (Fitzimmons and Fitzimmons 2011). Finally, vending removes the traditional need for time-dependent opening hours, yet retains the ability to transact goods on the 'there and then'. These features are at the heart of the swift and widespread adoption of vending machine technology, making it a unique retail

innovation. (Oinas-Kukkonen Harjumaa 2008a, 2008b, Fitzimmons and Fitzimmons 2011, Kim 2003).

These features may (although it is not clear at this stage) also impact the design of effective contracts and services, and the way that one might communicate with end service users and design the point of sale environment. Each of these unknowns it essentially a communication problem. It is through FM services such as vending that communication problems can lead to poor services that don't meet public health agendas.

1.8 FM services context

FM is the 'Integration of processes within an organisation to maintain and develop the agreed services which support and improve the effectiveness of its primary activities', and fits into many interpretations (IFMA 2012, BSI 2006, FM Link 2014, CEN 2006, Prodgers 2009, Davies 2011, Hall 1996, Mclennan 2004, Coenen and von Felton 2014). FM services in public sector health caring organisations such as the NHS are highly user-centric, and the complex technical medical systems and large workforces that lie within necessitate highly specified and variable service standards that are ultimately centred on the core organisational goal of providing care for the health of patients.

Vending services are managed in a way typical way of soft FM services at Barts Health Health: the service is subcontracted and managed as part of a bundled service, largely under a PFI agreement. In-house FM teams monitor services by collecting, analysing and reporting data, representing and ensuring the continuous meeting of service level agreements (SLAs). A service agreement is the agreement between the service provider and its customers quantifying the minimum acceptable service to the customer (Van Looy et al 2003 p169).

In comparison to SLAs, key performance indicators (KPIs) ensure that the organisational targets for success are being met. Often, the contractor is responsible for delivering the KPIs as well, and they are written into the contract as SLAs between the contractor and the Trust. This can lead to a dilution of intentions and service outcomes. In regards to vending, for example, the contract only stipulates that the service provider will ensure out-of-hours catering for staff, although the policies focus on well-being, nutrition, health and public health. Without any further specification in the contract, out-of-hours catering is achieved through vending and this results in a staff who only have access to confectionary, salty snacks and sugary drinks for large proportion of the time given that Barts Health is a 24-hour organisation. Vending services being provided by outsourced companies look very different from what is implied in the contract. This is indicative of output-specified contracts that do not contain detailed requirements, but are instead set to represent minimum standards and retain focus on cost-saving measures.

From an FM perspective, it is most important to maintain and develop the agreed services which support and improve the effectiveness of the NHS's primary activities as a carer of health (IFMA 2012, BSI 2006, FM Link 2014, CEN 2006, Prodgers 2009, Davies 2011, Hall 1996, Mclennan 2004, Coenen and von Felton 2014). FMs play a mediating role between potentially restrictive output-orientated service contracts, cost improvement plans (CIPS) and public health agendas. They must also meet building user needs and core organisational objectives of patient care on a daily basis, working in partnership with contracted service providers. This is a complex and challenging role and not enough was known as to how to improve vending services within this commercially-driven environment at the start of the project, and what the opportunities and restrictions may be.

The first part of this chapter has described some of the characteristics of vending services and the nature of the underlying problems using tangible examples and explanations. The second part does similarly but in research and analysis terms, introducing the problems from the perspective of the research communities who have strove to find solutions to similar problems.

1.9 The role of the primary research in witnessing the need for change

One role of this research project is to bear witness and to evidence the need for change in vending services that can be used to plan, build and implement effective performance measures. The concept of witness pervades many social constructs and is a powerful idea used in political theory, legal practice and performance art (Bretherton 2015, Bui 2015, Sepinuck 2013).

In managing an outsourced service, with monitoring and contract compliance management at the fore of activities, FM itself is a practice of witness. When these structures of FM reporting practices do not capture an emergent service delivery problem, such as the need for improved catering for night shift staff, capturing staff feedback is crucial to understand the service faults. Data-driven communication systems are often reliant on staff to report faults in a timely and correctly formatted manner and this in itself is another form of witness, has been noted as a particular area for improvement at Barts Health (Marmot 2010). Outsourced services that are driven by data collection can only function successfully given that they are input with accurate and timely data. FMs use this data to justify service change from within contract governance structures, that place their services under financial and resource constraints. As mentioned earlier, one of the key targets for policy is to understand and collect catering service data better in the NHS, and so meeting this goal services a strategic as well as operational purpose. The staff survey achieves this vital feedback.

A second type of FM data is that collected by service providers, such as sales records. Using commercially sensitive data such as sales records to justify service changes might be challenging as in-house teams may have limited access to such commercially protected data sets held by the outsourced contractors. This is common in FM with high volumes of outsourcing (Cotts et. al. 2010 p232-233). As this research is conducted from the perspective of in-house FM teams at Barts Health, the same hurdles might have affected the kinds of methods and tests available to use in this project. By focusing on the public health and research, rather than the revenue agenda, throughout the research, the problem was circumnavigated. The researcher formed a trusting relationship with suppliers that enabled access to sale records. Analysing sales data to judge point of sales interventions was the second form of witness that this research provided for the purpose of service improvement.

Without effective information gathering in vending, organisations such as the NHS are vulnerable to criticism as they may be failing to deliver public health agendas without even realising. Given that it is subcontracted service it therefore inherently lacks transparency. This research might provide the in-depth understanding needed to quantify the many unknowns of how to improve vending at Barts Health. In summary, this research hopes to contribute witness to the problems faced in delivering public health agendas through the primary research undertaken.

1.10 Connecting themes that run throughout the research

There are five connecting themes that run through this research. These are:

- Process
- Context
- Data
- Aesthetics
- Users

These connecting themes were first developed in the dissertation portion of this research project. The dissertation looked at a staff energy-saving behaviour change programme at Barts Health, called operations TLC. Similar to this research, a service change was needed in order to deliver government policy changes and service change was centred upon service user behaviours. This researcher combined a literature review with first-hand experience delivering the project. It conducted n-depth interviews with key stakeholders that were transcribed and coded to find emergent themes that either matched or diverged from the literature. The five factors were revealed to be central in understanding opportunities for service improvement through end service user engagement using communication technologies. A full copy of the dissertation and appendixes can be found in appendix B.

The five themes were found to be essential considerations in how communication can be a driver for positive service change and a focus on the end service user, as well as capturing all the linked opportunities. This set of five themes has been a useful tool in the thesis portion of this project, to understand and navigate the literature about communication and form a foundation of knowledge applicable to all types of communication. This was the point from where this researcher drew bespoke examples fitting to vending service improvement questions and communication opportunities. The dissertation was therefore a broader review of communication and its varying technologies, from where the thesis developed more narrow examples relating to vending. The dissertation was not vital to the thesis, but was instrumental in ensuring that the thesis addressed communication literature holistically and not only from the narrow perspective of the research problem. The dissertation was therefore largely out of the scope of the thesis.

The five themes that guide the research were:

- *Data* - this should form the foundation of service delivery mechanisms such as contracts, policies and supply chains, creating an accurate idea of service requirements from the user perspective.
- *Aesthetics* - the chosen mode by which knowledge is communicated in its applied environment; the colour one uses in a graph, the way signs are displayed in public areas.
- Users - central to all aspects of communication and often considered in terms of internal motivations for acting or changing behaviours towards an end goal.
- *Context* - the environment within which a service like vending is delivered, how it is designed and formally analysed and understood as a way to enrich service goals and apply communication technology.
- *Process* - might either be the processes of internal change that people go through when reassessing their behaviours, actions and/or decisions, and or the technical systems of processes within which vending services improvement takes place. Systems of processes tie together the service as a whole.

These are the five overarching agendas of communication that were found to impact end service user improvement plans in the dissertation: aesthetic, context, data, process, and users.

This model creates a pathway to move from strategy, policy, contract and audit requirements, to operational change that delivers public health in a tangible way. For example, the first piece of primary research, redesigning the point of sale and measuring impact, absorbs and considers elements from all five factors. Firstly, what the impact of the context in which vending machines are located has. Secondly, the way data is analysed and the appropriate statistical methods. Thirdly, the aesthetic of the interventions and how their design might be optimised to encourage healthier choices. Fourthly the processes, linking the elements of vending as a system and the individual process of change needed to create healthier lifestyle choices. And finally, the end user and their input explored through the survey. The five factors model ensures that the elements of the research projects maintain a communication focus and capture the necessary controls required for change.

1.11 Conclusion

The presence of vending traditionally encourages poor lifestyle choices, and automated food and drink vending is a serious concern for NHS Trusts like Barts Health, especially but not only for staff. The negative effects of poor lifestyle choices, such as having a bad diet, are exacerbated by the presence of vending machines (Ermetici et al 2016, Kelly et al 2012, Maliderou et al 2006, O'Hare 2015, Almeida et al 2014, Gemmil and Cotugna 2005, Capacci et. al. 2012, Chauliac and Hercberg 2012, Mesas et. al. 2012, Muñoz-Pareja et. al. 2013, Martin and Chauliac 2014). Their presence is an especially strong marker of poor diets and lifestyle choices in low income areas such as Barts Health constituencies, where obesity and other linked medical diseases to do with long-term health is also higher (O'Hare 2015, Barts 2016).

The health concerns linked to the kinds of confectionary products sold in automated food and drink vending machines raises a moral and reputational question as to whether vending should be available in a hospital (Kibblewhite et al 2010; Norton 2014). Making improvements is an attractive challenge for the NHS, as improving people's lifestyles and resultant long-term health might also reduce the costly burden of treating diet-related health problems as well as representing its core values of preventative health, as set forth in the 5yfv (NHS 2014 NHS England 2014).

There are several key service users who can benefit from improvements in vending services. The most critical group that this research hopes to influence, in accordance with policy and contracts currently in place, are staff working out-of-hours (Marmot 2010, Barts 2016, Kibblewhite et al 2010, Norton 2014, NHS England 2014). The hospital can also promote healthy lifestyles in the shared spaces where vending machines are situated and contribute to the collective identity of its community, directing the culture and values of its users towards healthier diets, rather than encourage poor choices (İnce Güney 2014). Better nourished staff can also provide better care and work more efficiently and take less time off sick, with significant financial savings attached (NHS England 2014, Marmot 2010, İnce Güney 2014). Funding opportunities for the Trust through QCUINs might become available by demonstrating improvements as well (Maruthappu 2015). Finally, the soft FM tender is a key opportunity to use this research to influence the contract structure.

There is active debate at policy and practice level about how to make improvements, given that vending is a complex, changeable system within Barts Health and the NHS (Churchman 1967, Rittel and Webber 1973, WHO 2015, Nice 2016, Nice 2015, The NHS England 2014, NHS England 2016, Maruthappu 2016, HPH 2015, DoH 2014, Boorman 2009). Traditional approaches to public administration may not be suitable as they rely on linear rational models with narrow measures

of success to fit into contractual frameworks, whilst public health measures and outcomes are ill-defined (French ministry of health 2012, EUFIC 2015, State Government of Victoria 2015, Nutrition Australia 2015, Medlineplus 2015, FSA 2014, WHO 2015, CDC 2012, Zock 2006, Phillips et al 2003, ten Have et al 2010, Terry-McElrath et al; Oborn et al 2011).

The key issue is creating a resilient vending service that is both responsive and well designed, with built-in, achievable monitoring, so that people understand how to use and provide services to the best of their ability. And to design and implement a service that accounts for hidden complexities in a changeable setting such as the NHS. There are a wide set of independent variables and human agendas and one must search for dynamic solutions and measurement tools that account for the entire service package.

Communication is an excellent area from which to draw solutions from as it cuts across every aspect of services and Barts Health should adopt communication technology to improve staff health and well-being through catering (Marmot 2010).

Although there is clear motivation to improve automated food and drink vending through communication, making tangible changes to service is a far more complex challenge than it first seems. Churchman's theory of wicked problems is an excellent description of the complexities in the research context. This research might provide the in-depth understanding needed to quantify the many unknowns of how to improve vending at Barts Health. This will contribute witness to the problems faced in delivering public health agendas and test the efficacy of potential communication solutions.

The first piece of primary research will design and test current intervention methods that might encourage healthier product choices. The aim was to gather point of sale information, including product sales, and use it to quantitatively test leading policy approaches that encourage healthier eating and healthier choices in NHS vending services at the service delivery and operational end of services.

The second piece of primary research will provide understanding of staff satisfaction levels with vending and demand and appetite for changes to retail night shift staff. Quantitatively analysing both data sets will contribute to policy, strategy, supply chain, service contracting, point of sale, and end service user engagement regarding vending service improvement and public health agendas.

Chapter 2 Defining the theoretical research problem space

This chapter is about defining the systems in which the research problem operates and this was a key challenge at the beginning of the project. At the start of the research project there was uncertainty about the relationship between vending in the NHS and the role that service design had delivering public health. By defining the ways in which the problem space can be perceived was later possible to identify key pieces of communication relevant to vending and service change within that problem space and how they linked together to maximise impact.

2.1 Socio-technical Systems of Communication Introduction

This chapter investigates how one might define the relationship between technologies of vending and social, human interactions and how communication can describe as well as mitigate or regulate that relationship. This chapter also describes the different ways to interpret elements of vending services as a system and how they each contribute understanding and definition to the research problem.

2.2 History of vending technology in society

In the NHS, it is intuitive that the space in which people work or visit, most especially if that space is a hospital, should promote healthy lifestyles and contribute to the collective identity of the community, representing the culture and values of its users, hopefully towards healthier diets, and not encourage poor lifestyle choices (İnce Güney 2014). Vending machine technologies are used to sell unhealthy products and contradict this sentiment. This section argues that vending technology enters many social systems in a similar way, creating moral, ethical and legal problems. This section will argue that vending machine technologies create an opportunity to circumnavigate moral and sometimes even legal barriers of trade that contradict social values such as public health (Bui 2015, Sepinuck 2013, Segrave 2002, Fulton 1995, DiFranza 1996, Kanda et. al. 2010, Minowa and Satomi 1993, Tomnay and Hatch 2013, Brown et. al. 1997, Moatti et. al. 2013, Bretherton 2015). It also inherently enables taboo behaviours.

Vending machines have existed in primitive forms since before Christ. Coin operated holy water dispensaries for example made it quicker and more efficient to profit from the sale of holy water in temples (Segrave 2002). In this earliest of examples, vending technology prevents having a holly member of the temple directly accepting money for their religious services also portioning the water and resolving the resource issues of people taking too much water at once.

Primitive vending machines were also used to automatically open drawbridges (Segrave 2002). This might have protected money collectors from people's objections to paying entry. Using deep coin slots where people inserted their money rather than a person might have also avoided robberies. The operators themselves may even have been tempted to withhold money paid to them or allow free entry to friends and family. It would be difficult to monitor from behind defensive walls. In modern society, automated payment on buses and other transport systems has a similar effect of preventing robbery and theft.

Vending machines continued to evolve in seventeenth century in English taverns when coin operated vending boxes were used to sell snuff boxes, a product intermittently banned and made illegal (Segrave 2002). In a later nineteenth century example, Richard Carlile sold controversial political books, such as Thomas Paine's The Age of Reason, through the same kind of vending machines, pushing the freedom of the English press and attempting, unsuccessfully, to avoid arrest for his illegal acts by relying on the automated nature of vending machine distribution (Segrave 2002).

In 1833, Percival Everitt developed vending machine technology further, to supply products such as postage stamps, handkerchiefs, cigarettes, confections and even fortunes on Sundays, when shops were closed in accordance with religious law at the time (Segrave 2002). Soon Everitt had to develop patents to protect against the regular vandalism of vending machines. People pushed paper, orange peel and other rubbish in the coin slots.

In the 1990s, a flurry of research in places such as Japan appeared regarding how to stop tobacco being sold to under age people who were buying it illegally it from vending machines, before it was eventually banned in many countries including the UK (Fulton 1995, DiFranza 1996, Kanda et. al. 2010, Minowa and Satomi 1993). Research also exists on the sale of contraceptives through vending machines in religious communities in the USA, where, again, underage young people were regular customers (Tomnay and Hatch 2013, Brown et. al. 1997). In Japan, vending machines even sold used panties before their eventual ban and replacement by synthetic versions. Finally, the distribution of syringes via vending machines has been another subject of research in France and other countries to encourage use of clean needles for heroin use and combat HIV (Moatti et. al. 2013). Vending machines offer both the distributors and customers anonymity.

In the NHS today, confectionary, salty snacks and sugary drinks are the taboo products that might one day become prohibited. France has already banned vending in its schools, for example (Capacci et. al. 2012). Not only are they at odds with the health caring role of the organisation, there is also the underlying consideration that the raw ingredients, especially sugar, are manufactured based on the systematic exploitation of farming communities and human rights violations spanning centuries (Fairtrade 2016).

In conclusion, the historical evidence strongly suggests that the role of vending in society has been to circumnavigate a range of moral and legal dilemmas dictated by the societies in which they have appeared throughout history. As a vehicle for taboo, and even illegal, retail it is perhaps the case that bespoke, morally-guided retail standards are needed to control this impressive and large global sector more tightly. In the context of the NHS, the boundaries of what is and is not morally acceptable to public health are changeable, especially given that preventative healthcare policies are new and evolving. FMs will have to adapt and move with these changes in the way that vending, and all FM services are designed and delivered.

2.3 The system of communication in which vending is regulated in the NHS

In the context of the NHS there are several formal elements of communication that exist to regulate vending. The previous section was a broad look at the relationship between vending technology and society, however this section focuses only on that relationship in the context of the NHS. It focuses on elements of communication that form a system by which to deliver public health agendas in NHS food and drink automated vending. The diagram presented in the diagram below represents these formal elements of communication as a system, describing the set of mechanisms through which vending might become more effectively regulated and designed.

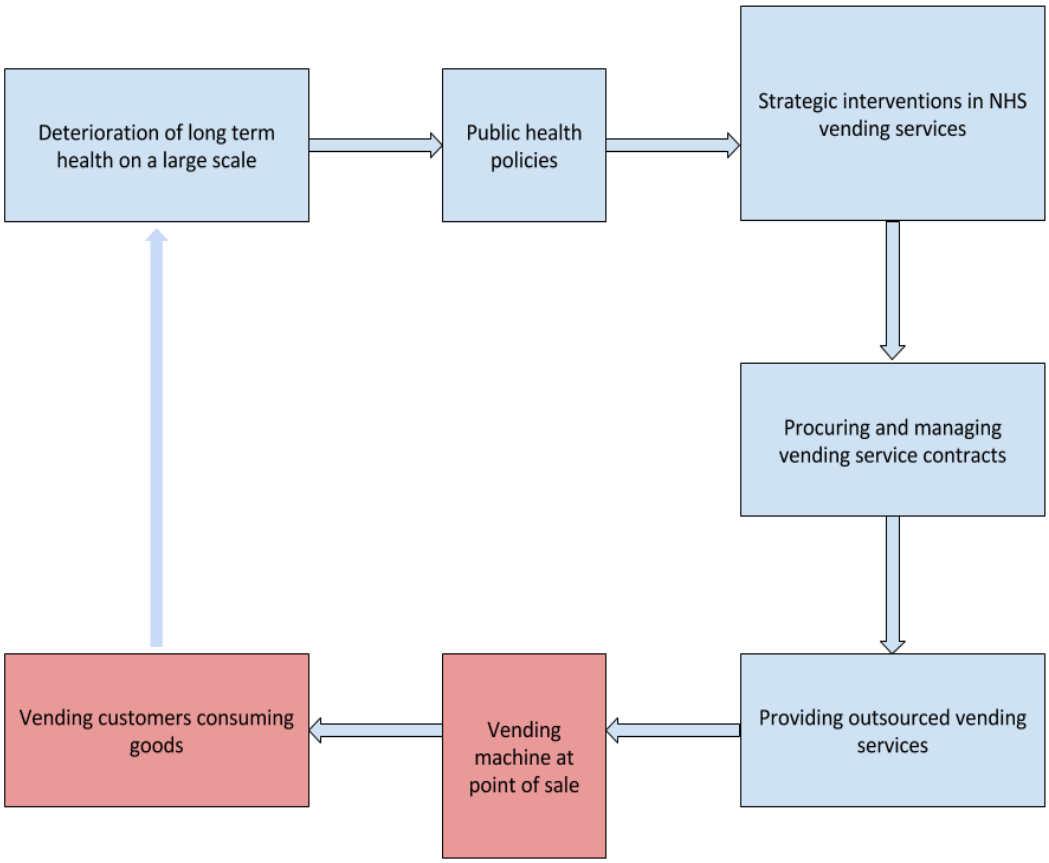


Figure 2 Diagram of vending service improvement opportunities

The next chapter will investigate these elements and look for potential gaps and solutions to improving service. This chapter first considers how these elements can and have been described in the literature as a system at a more conceptual level. For example, the creation of the diagram above was informed by an engineering-based approach to systems thinking. The engineering based approach refers to the one used in operations research (OR) and systems dynamics (SD). It emphasises linear sets of hierarchical and bounded areas in a system such as vending services that might be addressed individually to inform improvements (Sterman 2000, Simon 1962, Rittel and Webber 1973). In this diagram each bounded element, placed in a service delivery hierarchy that contains health and consumer behaviours, is considered a piece of communication or signpost to pieces of communication that can be used to make improvements.

Each element is also considered in light of first-hand experience. The diagram itself was built based on this first-hand experience, strengthened by working in vending services at Barts Health. Modelling service processes is typically done in this way (Van Looy et al 2003). It describes the research problem space within which the next chapter reviews the available communication technologies to deliver service improvement towards public health policies in each area. It is, therefore, not meant as a true reflection of vending services, which are in reality made up of systems far more embedded in catering service, and non-linear or hierarchical processes. Given that these groupings are rooted in first-hand experience, they do, however, predict and inform the intended impact of service communication design literature which aims to change and improve services. They also hint at the adjacent areas of impact that changes to service might have across vending services. This chapter discusses each section of the diagram in turn.

2.4 Related models of socio-technical systems

The elements of communication in the diagram above, and the relationship between vending technology and society are an example of socio-technical systems. The non-human aspect is the vending machine technology and the human aspect is the staff and other stakeholders depending on it. This research must understand how communication can be grouped and then applied using research technologies within this system as a lever for change. As a whole, this must produce an understanding of how to improve automated food and drink vending services towards public health agendas.

Sustainability as a model for socio technical problems

Several established definitions of systems that can be overlaid with vending service systems already exist, to do firstly with sustainability and secondly with service management. They illustrate agendas of cost savings, commercial opportunity and public health that must be considered in each element of communication. For example, the model in Figure 3 of the universal factors of sustainable systems.

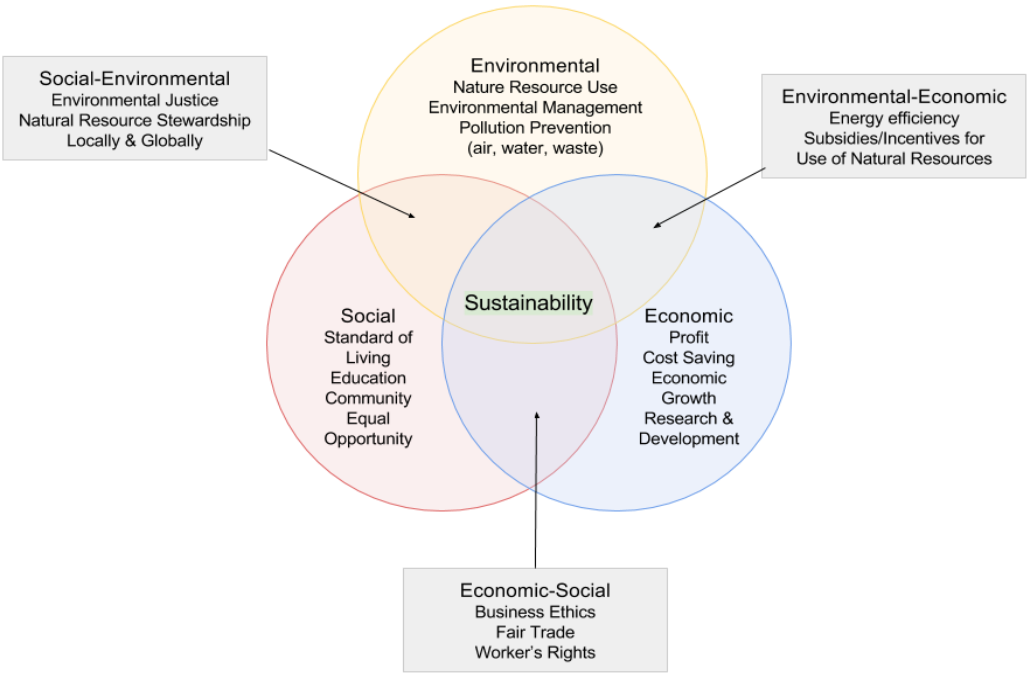


Figure 3 Spheres of sustainability (Rodriguez et al 2002)

This represents the generic socio-technical system of sustainability and the vending services problem also fits into it. Delivering a mix of public health and economic agendas is challenging, but the diagram above begins to illuminate how these agendas are overlapping from an FM perspective.

Systems thinkers have long worked to help solve such problems as balancing multiple stakeholder agendas encapsulated by the sustainability model within complex settings like the NHS, linking social and technical aspects together in applied settings, and focusing on 'New management and working practices, accompanied, facilitated or enabled by the introduction of new technologies' (Clegg 2000, Dym and Little 1999).

Service based socio-technical systems

To understand the research problem, a model of service communication within the vending system must cover the entire service package, from a service design and service change perspective. The same elements of the service package might be present in any soft FM service, therefore the service model shown in Figure 4 summarises the role of information and communication within vending services:

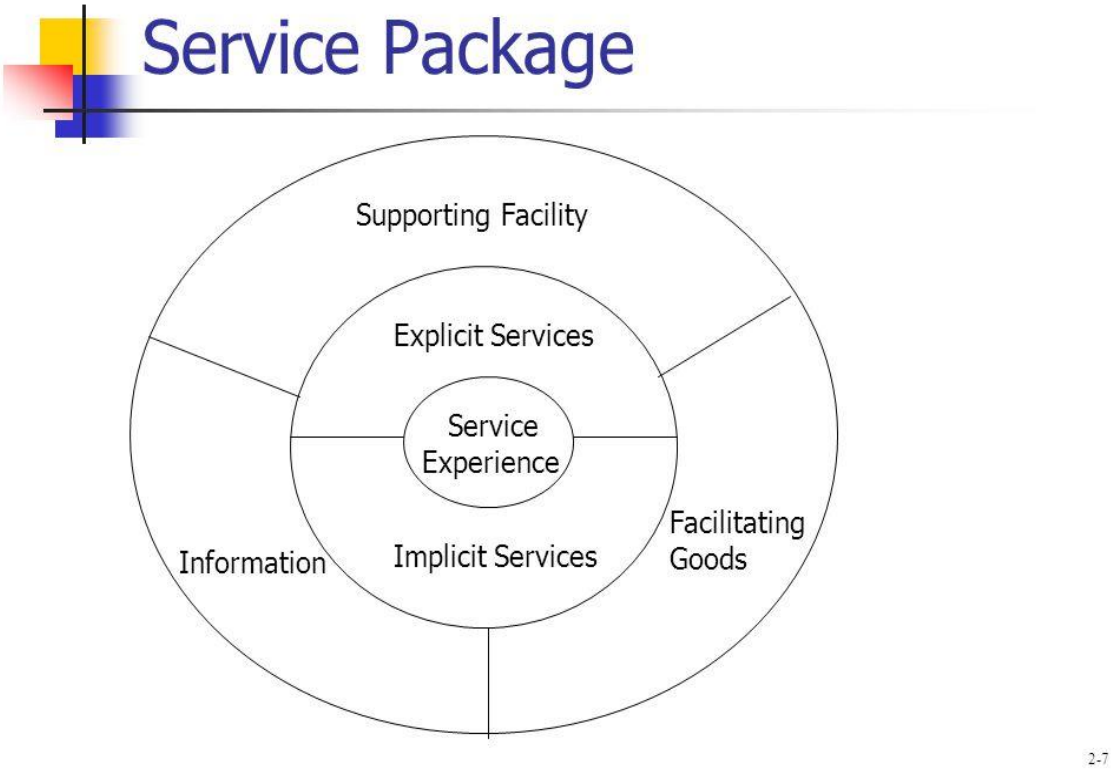


Figure 4 *Service Package* (Fitzimmons and Fitzimmons 2011)

The different aspects of vending services are captured in this diagram, as any other service might be. However, this researcher would argue that communication is so critical to service delivery that it should be included on the model. The model does, however, offer headings under which to describe the main factors of vending services.

In vending services, the explicit services being offered are sustenance – food and drink – especially during out-of-hours periods of time when other retail outlets are closed and the Trust has a burden of care for its staff. The implicit services provided are to do with the psychological impact of the good consumed, a contribution to the customer's long-term health, and also the Barts Health public image of selling products in the hospitals. The supporting facility is the physical resource of the healthcare space. The facilitating goods comprise of the money transacted in the sale of products like chocolate and crisps.

Most importantly for this research, the diverse information in the vending service package includes:

- Policy documents
- Strategy vision
- Auditing of supply chain
- Contracts
- Sales data
- End user surveys

The nutritional properties of goods being sold and consumed by NHS stakeholders is another of the critical pieces of information to the communication system being presented in this research; the core measure being changed. Information gathering is also incentivised in the Commissioning for Quality and Innovation CQUIN 4 (DoH 2014).

Although it is not mentioned explicitly in the Fitzimmons and Fitzimmons (2011) model, communication is critical to the service package. Perhaps more than the other elements of the diagram, information is meant to capture the role of communication. Considering the different kinds of information in the vending service package, one can understand the research methods required to gather and communicate effectively and the available channels of communication in the project.

2.5 Systems about end service users

Public health guidance must assimilate end service user engagement to communicate meaningfully with the end service users of vending machines about their product choices, and to gauge their satisfaction levels. Speaking more widely, FM services are deeply reliant on the end user engagement meaning contractual performance measures and data sets about service delivery should reflect user behaviours (Campbell 2016).

Given the importance of end service users in design across a wide spectrum of practices, including soft FM and vending services, it is critical to avoid a lineage of object orientated research and ill-fitting designs that ignore or marginalise the service user and their influential role in determining complex performance outcomes. The current situation, however, presents disparate design models, that hinder the development of understanding end service users (BIFM 2013, Martin and Guerin 2006, Nenonen and Sarasoja 2014).

One way to design for service improvement that benefits end service users is to use models of psychology – behaviour, choices, learning and actions – and this is common in computer science-based approaches to communication (Consolvo et al 2009, Comber et al 2013, Darby 2006, Oinas-Kukkonen Harjumaa 2008b, Fogg 2003, Tufte 2001, Tollmar et al 2013, Brewer et al 2011, Fan et al 2012, Strasser et al 2012, Cairo 2012).

J.B. Fogg's model (Figure 5), developed to cope with technology design for behaviour change, can be used to map the individual motivation versus the ability to act, connecting and mapping the two key variables moving towards a desired action (2009).

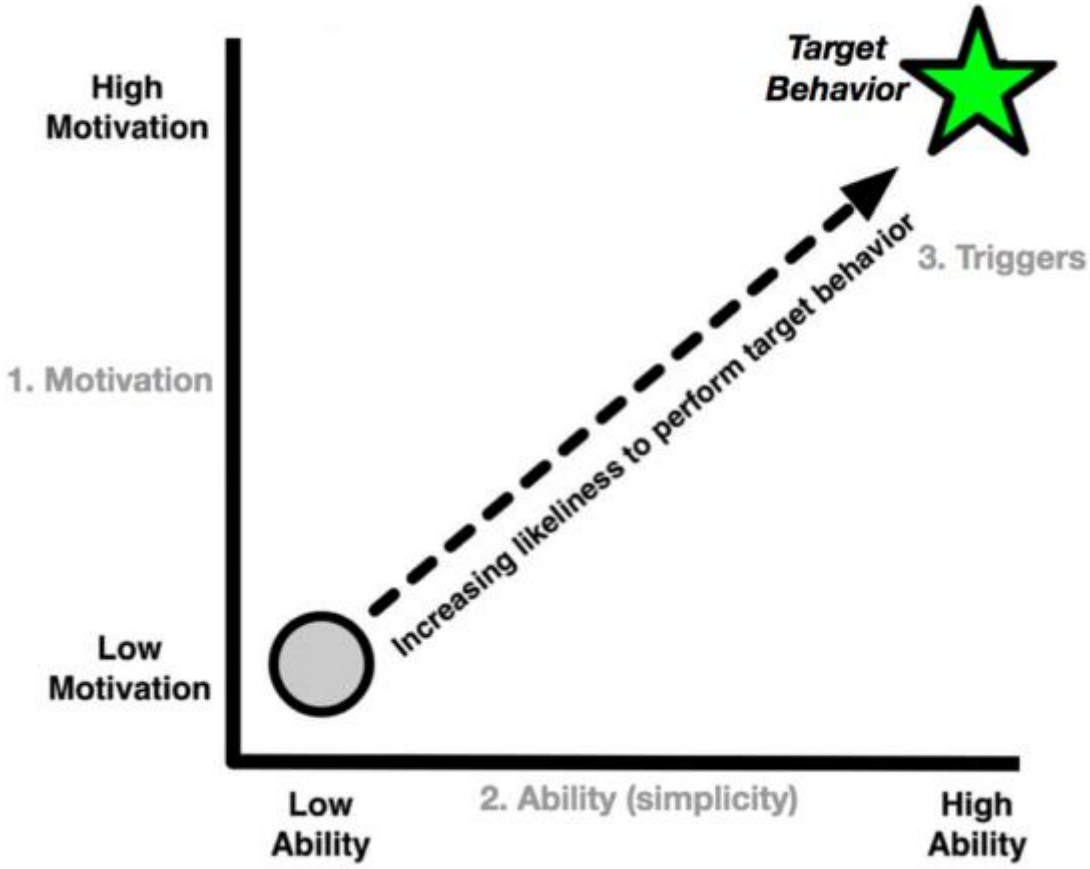


Figure 5 Behaviour model of motivation, ability and triggers (Fogg 2009)

This model creates a pedagogical link between behaviours and outcomes using linear and hierarchical approaches (Klostermann and Thüring 2007, Price and Petre 2004). It blends internal and external drivers on an individual, as either could be a motivator or enabler, targeting behaviours or decisions that one might seek to influence in the process of service improvement. It could be used to map intended change for a range of vending service stakeholders. End service users might have no access to healthy options or little time to stop and find them compared to ample breaks and a wide selection of nutritious options to choose from. The difference would naturally influence and encourage healthy choices.

Fogg's map can be likened to Churchman's ideals about wicked problems (presented in chapter 1), in which one can group opportunities for behaviour change, retaining a focus on subjectivity and the disorder of parts, and evade bounded hierarchies and the breaking down of the overall system into smaller parts (Ulrich 1980, Churchman 1967). There is hierarchy in Fogg's model, but it is entirely subjective and changeable depending on what motivators and enablers are being considered, offering flexibility.

Systems about processes and users

This comparison between Fogg and Churchman sits in contrast to theories such as SD and OR. These theories assert ways in which component parts of a system like vending services can be given order, and each component might be tackled individually (Sterman 2000 p.513, Simon 1962, Rittel and Webber 1973).

In OR, Ramussen produced a human factors model of decision making, called the Skills, Rules, Knowledge (SRK) framework (Figure 6), focusing on the structure within which people make decisions (Wickens et al. 2003).

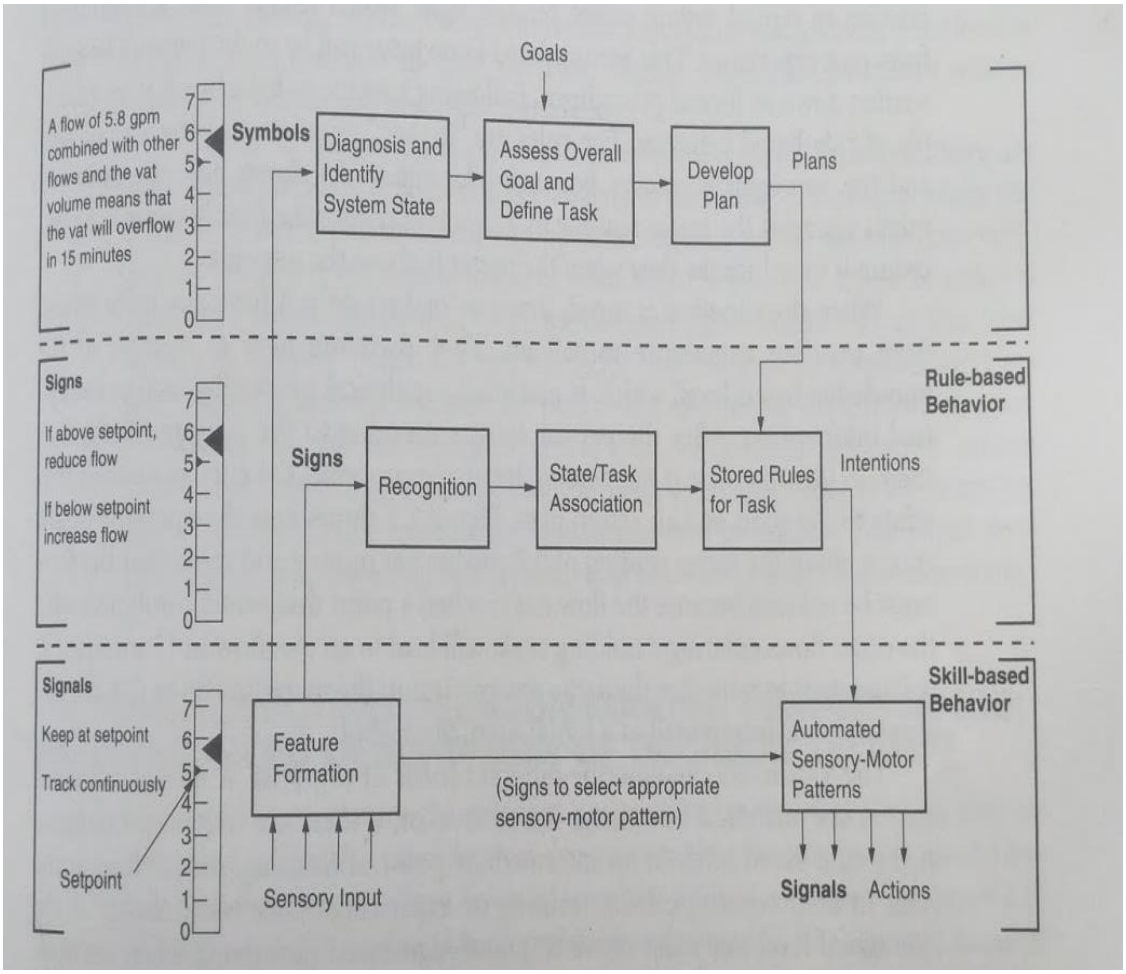


Figure 6 *SRK Framework for decision making* (Ramussen 1983)

The SRK model assigns motivations in an operations setting, represented outside the boxes. Intentions, plans and sensory inputs, might all be considered motivational aspects of the model. Capacity to act is represented inside the boxes, relying, for example, on sensory motor patterns, diagnostics and plan development.

The top tier describes knowledge-based behaviour, in which users might require more complex symbols to act accordingly, reflecting specialist knowledge. This is the domain that systems thinkers Rittel and Webber (1973) advise should be the main focus in fixing or finding solutions to wicked problems. The middle tier links simpler signs to simpler rules-based actions and the bottom considers automated behaviours and skills.

Similar to the model above, Nudge Theory highlights the idea of cognitive and automatic thinking and action (Thaler and Sunstein 2008). There is an underlying distinction between the influence of reflective, cognitive pathways, and non-reflective automatic pathways that influence behaviours and physical activity (Skov et al 2013). This echoes the model presented by Ramussen (1983) and ideas presented by Simon (1962). Similarly, too, in SD a distinction is made about automated versus deliberate decisions (Sternman 2000).

Nudge Theory addresses internal complexities that lead to action that are not addressed in human factors models such as Ramussen's. This creates a distinction between the two approaches: encouragement and persuasion in Nudge versus the assumption of compliance in human factors models, given that the 'operator' is already being paid to do the job in question.

The three-tier model of users is arguably ill-fitted to the vending problem given that it was developed for work types in mechanical engineering settings, with a lack of focus on non-standardised motivators and enablers. It is, however, conducive for a formal understanding of how to improve systems based on a model of communication, given that the human element of the system can be introduced where lacking.

2.6 Systems of processes

This chapter has so far interpreted and discussed different types of systems models and maps. This research then went on to design a bespoke system map for vending services, drawing on SD. A simplistic model was already created by this researcher as a narrative tool, to show the elements of communication in the vending service problem (see Figure 2). This section presents the second model created by this researcher, to further interrogate the assumptions of defining the vending services problem space. A process-driven, systems approach to modelling was used as a communication tool and for representing a range of stakeholder decisions, motivations and capacities for actions in the system (Tako and Robinson 2009, Strijbos 2010, Thompson and Bank 2009, Checkland 1994, Ramussen 1983, Fogg 2009). This approach has helped to clarify processes, key stages and stakeholders that are a core part of the larger systems of communication in vending services.

To create a model of a system like vending services, in which processes are harnessed and designed effectively, one must understand both processes of objects and those of people. In Figure 5, presented earlier in this chapter, Fogg (2009) presents an example of how one might interpret systems of people, and Ramussen (Figure 6) (1983) focuses more on objects. One without the other is however inadequate, as history has proven, when systems approaches have in the past ignored human elements. For example, the design of tower blocks was based on systems thinking, resulting in crude and excessive uses of mechanistic design, unsociable spaces that have been shown to encourage anti-social behaviour as a result, seen by many as a failure of design (O'Brien 2014).

The development of systems dynamics has emphasised social connections within a system and production of objects (Simon 1962). The SRK model and Fogg model presented earlier (Figure 5 and 6) are a step towards this as well. Using SD and designating the least healthy products as 'RED' products, a model of vending services as a system was created (Figure 7). The model represents opportunity for change within the parameters of the current vending service system. Given that it is not feasible for FMs to ban the least healthy products completely and the lack of policy and government support, one could represent the vending problem at point of sale using SD. This model helped to highlight some of the key variables and shape the research thinking.

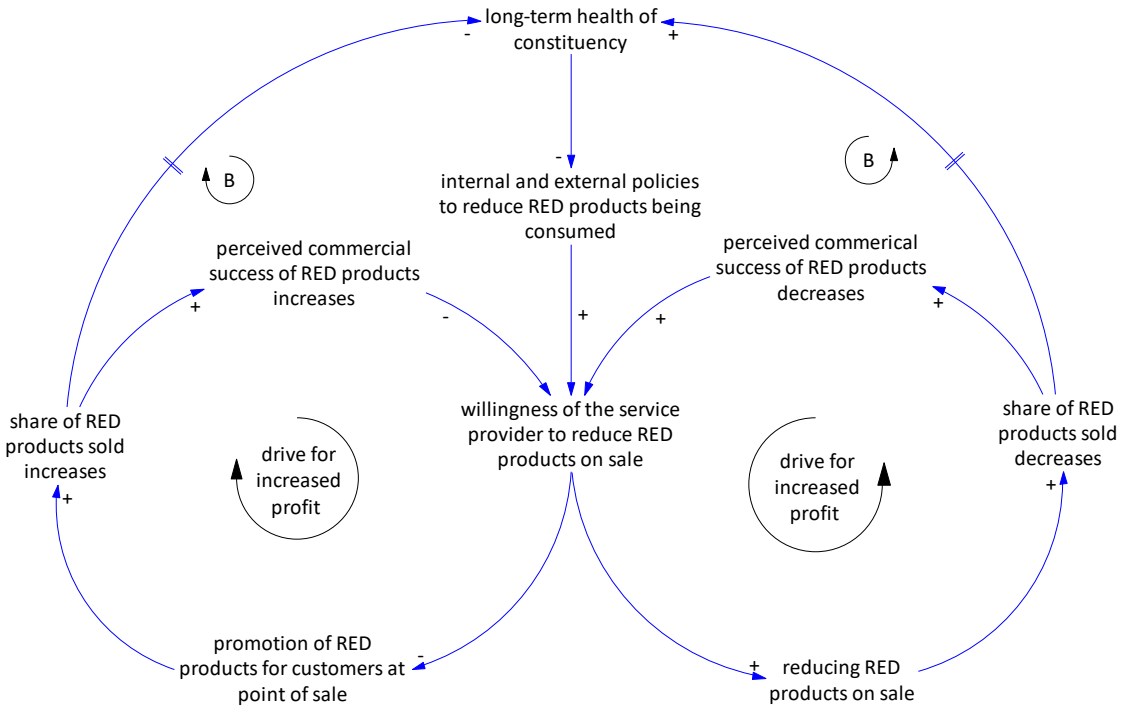


Figure 7 Socio-technical model of vending

In this model, the willingness of the service provider is driven by the model imagines that 'RED' products (unhealthy products to be classified by the Trust based on the nutritional guides discussed), must be decreased throughout the system, showing the interconnectedness and reinforcement of either feedback loop depending on if it achieves this. The two top loops with the letter B, and the dash through the line next to them, indicate in SD language that the system is being balanced by a long-term balancing loop at that point. The + - signs indicate the direction of flow of the system.

A key problem in driving the kind of change that the above model describes, is that currently this system is controlled by the vending service company. It is the mechanism within which Barts Health must push its own public health agendas but that it cannot control without changing user behaviour or perception of service, ultimately relying on profit to determine the products sold.

Systems thinking can be a tool for those who 'Strive to optimize a system (vending services) but lack knowledge of the system structure that might help them identify the optimal operating point (a balance between public health and economic agendas) (Sterman 2000 p.537). Subsequent practices, such as SD and OR, also allow one to combine social and technical factors. Having the system defined can itself then be useful as a communication tool for representing a range of stakeholder decisions in vending services (Tako and Robinson 2009, Strijbos 2010, Thompson and Bank 2009, Checkland 1994). At the beginning of this chapter, for example, a simple version of a systems model helped to communicate the areas of focus in the research (Figure 2).

In other instances, the intended outcome within a set of processes or system is already identified and the system can then be represented by describing the ways that a process, or sequence of activities, can deliver the expected outcomes in a reliable way and at a satisfactory level of quality, including how users 'should' act (Van Looy et al 2003 p10-11, Klostermann and Thüring 2007, Price and Petre 2004).

In the vending system, the service was defined in the course of the scoping of the research, forming the preliminary work. While the mechanisms were relatively straightforward to define, the core measures, as well as measures of the intended outcome, were not yet clarified. The use of 'RED' products is a substitute where these elements are lacking, but is as yet untested. This makes it very difficult to validate or justify why an SD approach is suitable here.

The key theorist dealing with decision making, information and communication in SD, Simon (1962), embraced bounded hierarchies, similar to systems thinkers Rittel and Webber's, who furthered Churchman's work (Sterman 2000 p.537, Rittel and Webber 1973). This is in keeping with the model presented above, where the measures (imagined in this case) are well-defined and there are links to an overarching outcome.

2.7 Conclusion

This chapter has discussed the types of models of socio-technical systems that have been developed in differing fields to account for the role of people and technology, in this instance end service users and vending machines. Throughout the chapter it has become clear that the literature often searches for ways to bring together social and technical elements of a system in order to influence end users towards improvement goals and to solve industry focused problems such as vending service improvement. This has been discussed in several different but overlapping ways.

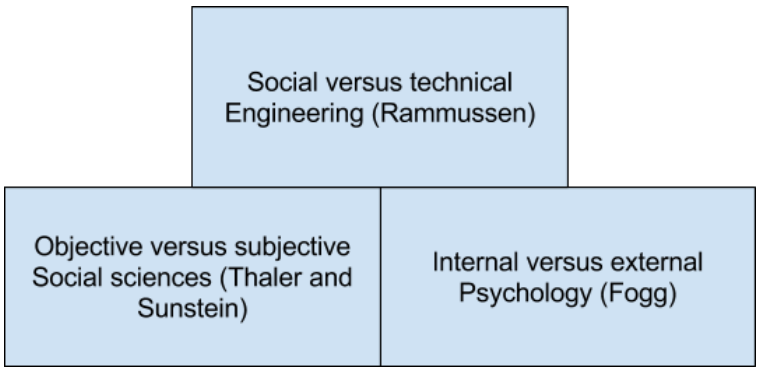


Figure 8 Common themes within the literature addressing improvement goals

Often the terms being discussed in the literature are closely related. Examples are given for each in brackets in the diagram in Figure 8. These three pairs of terms were used frequently as interchangeable and they often appear in similar discussions.

In order to test what a system map might look like for vending this chapter a more recent development in engineering, SD. This approach blends the overlapping agendas presented in the diagram in Figure 8 and serves to highlight the dominant relationships influencing potential improvement in vending services. It describes the problems and potential pathways to solutions but does not however show actions of how to make improvements. SD would only be appropriate where clear and singular measurements have been defined, which is not the case in NHS vending. The measures for what is healthy have not yet been discovered, and this is one of the problems that will be explored in the next chapter.

In the primary research, redesigning point of sale helps to move people towards the desired behaviour, increasing capacity and motivation to make healthier choices by creating favourable design of the point of sale environment. The survey analysed what staff motivation to act may

be given potential constriction on capacity to act within the current service design for out-of-hours retail catering. It is likely to be low given that vending is the only retail option out-of-hours.

In regards to the SRK model, the interventions encouraged people's intuitive and automated decision making. The next chapter will elaborate on the detailed design of each intervention. The survey baselined how the rules of working practice are currently helping or hindering desirable public health outcomes and both allow evidence-based and measurement-driven controls to be put in place at the planning level of the SRK model.

In comparison to the systems mapping or modelling approaches presented in this chapter, Churchman's work on Wicked Problems that was quoted at the beginning of the introduction to this thesis strongly warned against bounding and creating hierarchies for complex problems. In this research, whilst the models presented in the chapter have been useful as communication tools in their own right and opened up thinking over the nature of the research problem, the models produced do not offer tangible instruction on implementing change, much like the policies, strategies, contracts and supply chain audits currently in place themselves. The are essentially a high-level set of tools with little link to operational practice or FM. Churchman's emphasis on subjectivity and the disorder of parts and warnings not to oversimplify are, however, more reflective of the current state of vending services (Ulrich 1980, Churchman 1967).

A model must combine objective and subjective and social and technical to accurately represent vending services, as well incorporating expected outcomes and the interconnected parts using hierarchies and different bounded processes, but at the same time acknowledging the limitation of a model that could never describe the reality fully (Strijbos 2010, RAE 2015, Simon 1962, Sterman 2000 p.513, Rittel and Webber 1973, Churchman 1967, Ulrich 1980, O'Brien 2014). The implied rationale is that this requires agreed measurements and preparedness to bound subsections within a system, both major assumptions given the overlapping, ill-defined changeable nature of FM services such as vending.

In conclusion, the systems approach has reached its limit of usefulness in this project when it has been used as a communication tool to define and describe the system of the problem space, rather than to change or improve the system. It is a vital step towards reaching a conclusion about the potential improvements that one might make, but not in itself a solution. The primary research will offer this opportunity independently and the next chapter will look in detail at the specific communication available within the vending system to leverage improvements. This involves the strategy documents, end service user engagement, point of sale environment, audits and contracts that are all essentially communication.

Chapter 3 Literature review of communication solutions across vending services

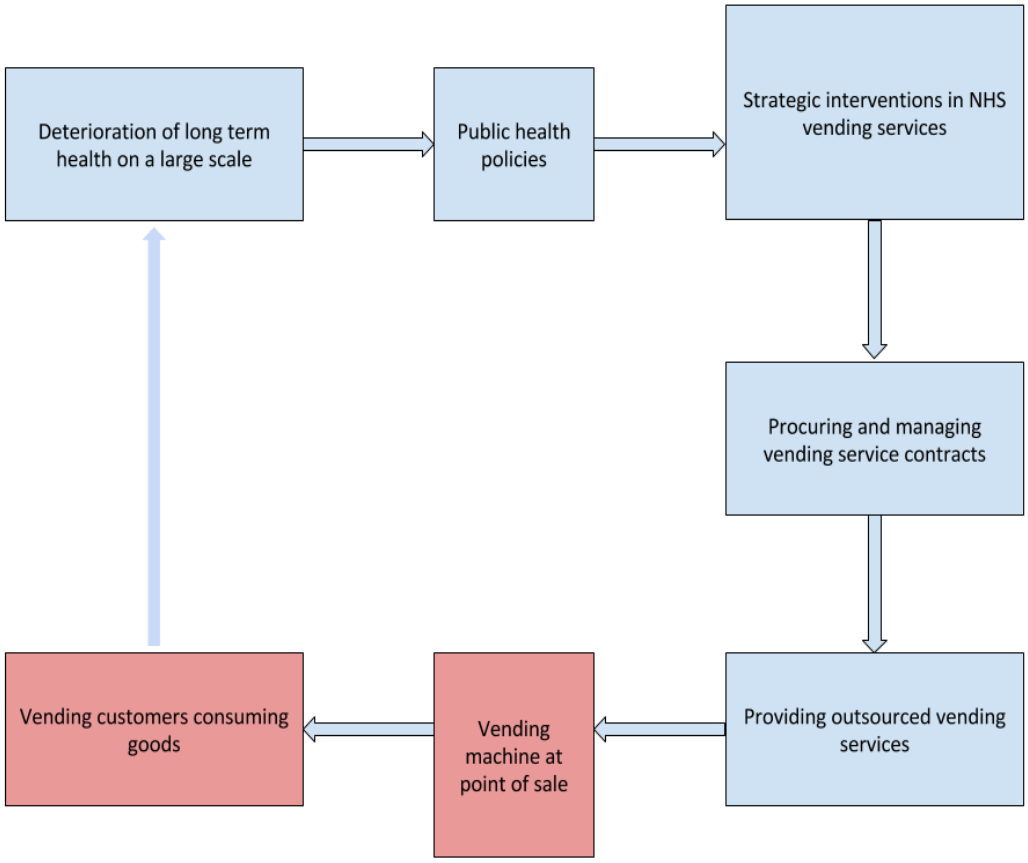


Figure 9 Diagram of vending service improvement opportunities

3.1 Introduction

This chapter begins with a consideration of the high-level influencers in vending services, the policy, strategy, and the delivery of outsourced vending service contracts involved in vending services. It considers the existing communication tools in these elements of service might help as pieces of communication in their own right, to improve vending services.

The second half of the literature review moves towards communication at the user end of service, which is where the primary research activities took place. This includes the point of sale and end service user research work, conducted to inform service improvement goals, as well as collecting and analysing data that would be valuable in deciding the best courses of action at all levels. This chapter is aimed towards finding potential communication solutions that can either be described and or tested in the primary research.

It is atypical for a research project to cross so many areas of research within one project. The result is that targeted areas of literature are reviewed from distinctive fields of research. The way that literature was chosen was based upon operational experience working in Barts Health, revealing the need for further understanding in chosen areas that are investigated in this chapter. From this researcher's first hand operational experience came the understanding of what problems the organisation faced. Where answers could be provided in the literature they are described in this chapter, and where no solutions were found, there is consideration of how

the primary research might offer solution. This chapter is therefore part literature review, part method development.

3.2 Establishing the role of public health policy in service improvement

This section evaluates some of the available policy guides and isolates guidance that provides promising measures that can be used towards vending service improvement by FMs. The Government Buying Standards (GBS) are a special focus, given that it is targeted at FMs and service providers making and governing healthier procurement decisions and it can be applied to vending specifically.

Overview of related UK policy guides

The UK government has called for comprehensive, hard-hitting and broad-based national action for the improvement of food and drink services in the NHS, aimed, amongst other agendas, at preventing the deterioration of long-term health. NHS catering improvement plans, including vending, began primarily from dissatisfaction with patient catering, and have since grown to include and coordinate with public health policies. Healthier behaviour is being incentivised and supported by the NHS in the context of preventative measures, particularly targeting issues such as smoking, alcohol consumption and poor diets in healthcare, and encouraging staff lifestyle improvements internally (NHS 2016, Marmot 2010; NHS England 2016 b). Non-patient catering service improvement plans also overlap with preventative models of healthcare: initiatives to link with the community, health education, and supporting staff, patients and stakeholders in healthcare facilities to make the 'right' choices (WHO 2015, Nice 2016, FFLP 2016, Nice 2015, NHS England 2014, Maruthappu 2016 HPH 2015, NHS 2016, NHS England 2016 b.).

Several guides lead in communicating policy such as the formation of the Hospital Food Standards panel (HFSP) marks the formal union of a wide range of policy agendas aimed at NHS catering improvement combined in a guideline report for industry. Meeting Food Standards Guidance produced by the HFSP is a mandated requirement of catering service provision in the NHS, as stipulated in the NHS Standard Contract. Section SC19 of the Standard Contract now stipulates that that service providers must develop and maintain a food and drink strategy as well as meeting the Food Standards Guidance produced by the HFSP (HFSP 2014).

Another piece of policy documentation that is significant in catering improvement is the GBS, produced by the Department of Environment, Food and Rural Affairs (DEFRA). For FMs, the GBS is especially important as it can directly influence procurement practices and is mentioned in the HFSP report in the sustainable food and catering services section as a core goal that FMs should meet. At the same time, the GBS is in a developmental stage and is also currently voluntary. It requires testing and reflection to understand whether it is fit for purpose.

Amid changing public health agendas, FMs in healthcare must work with other departments to deliver this change while at the same time taking ownership of policy guides that specifically target FM practice and improvement.

The GBS published by DEFRA 2005

In accordance with policy guidance, it is hoped that applying collective local efforts such as healthy food procurement might cumulatively lead to a shift in the demand for healthier foods, thereby nudging the food supply toward a healthier norm (Robles et al. 2012).

The GBS is the targeted guide for NHS and other public organisations to create procurement standards and could be applied to vending services (DEFRA 2015). The GBS stipulates that with portion sizes of less than 100g or 100ml (typical in vending machines):

Nutrient	Nutrient must contain less than
Fat	20 grams for 100 grams of products or 10 grams per millilitres
Saturated fat	5 grams for 100 grams of products or 2.5 grams per millilitres
Added sugar (not including sugars from dried fruit or milk)	12.5 grams for 100 grams of products or 6.3 grams per millilitres
Salt	1.5 grams for 100 grams of products or 1.5 grams per millilitres
Sodium	0.5 grams for 100 grams of products or 0.5 grams per millilitres

Figure 10 *Nutrient specifications for smaller portion sizes (less than 100 grams)* (DEFRA 2015)

This guide is set to 'high' on the Food Standards Agency (FSA) nutritional guidance (FSA 2005). For example, products containing >20g fat are considered to have high fat content by the FSA. Given the portion sizes in vending machine products are frequently under 100 grams or millilitres, vending product procurement can be governed by this guide.

The GBS also stipulates that:

- Snacks are only available in packet sizes of 30g or less;
- Confectionery and packet sweet snacks are in the smallest standard single serve portion size available within the market and not to exceed 250kcal;
- All sugar sweetened beverages to be no more than 330ml pack size;
- No more than 20% of beverages (procured by volume) may be sugar sweetened;
- No less than 80% of beverages (procured by volume) may be low calorie/no added sugar beverages (including fruit juice and water).

The word 'snack' is not well defined, leaving a gap in the ability to apply such guides in vending service improvement with confidence. Without this, it will be difficult for organisations to create meaningful change in procurement in vending as providers will not be sure which products to apply the regulations to.

The GBS, FSA and many other public health guides use a technique called nutritional profiling. This is 'the science of categorising foods according to their nutritional composition' (Foltran et al. (2010). Various nutrient profiling systems have been developed throughout the world, and applied in a variety of consumer information and regulatory contexts. They vary in terms of the importance placed on different nutrients (Rayner and Stockly 2004). Some will be explored throughout this chapter in relation to vending. A common guide is that one can communicate recommended daily allowance (RDA) of food and drink by using calories (kcal): 2,000 for women, 2,500 for men (EUFIC 2015). This is another example of a nutritional profile.

It is not clear if it is feasible for this guide to be integrated and used in vending and catering service improvement or whether Barts Health is capable of, or willing, to meet the standards. To find this out, this researcher was part of the DEFRA working group that met quarterly to

discuss the guide and its usefulness. This researcher was an active member of the working group throughout the four years of thesis project. To embed the guide and report back on its efficacy in the Barts Health setting, this researcher worked with the senior management teams. This was also to evaluate Barts Health's capacity to meet the standards.

Outside of the primary research activities in this project, the researcher developed questionnaires based on the GBS policy guidance and used them to conduct in-depth interviews with a critical sample of service delivery, contracting and management representatives, creating a gap analysis of the policy position versus supplier service standards and current provision for the Trust and DEFRA. This meant engaging vending and catering supply chain representatives and convincing them of the value of the work being done during a sensitive period of soft FM retendering. The answers from the questionnaires resulted in an internal report for senior management, as well as feedback to DEFRA about the guide. The same report was then adapted into a 'policy pack', and distributed to companies submitting to tender for the soft FM contract at Barts Health.

This is an example of where the in depth scoping and close working with Barts Health meant that the researcher was working on projects outside of the primary research that helped the overall aim of service improvement. It might, given a larger project scope, have been made into a whole other primary research activity with qualitative methods being explored and applied.

Wider UK policy guidance for NHS catering including vending

The main points of guidance from the available policy guides on NHS catering improvement, other than the GBS, which might inform vending service improvement, are listed below. These are some of the most common policy goals and measures found in the literature, discussed in more detail later:

Public Health Policies:

- Comprehensive, hard-hitting and broad-based national action (for the improvement of food and drink services).

Strategic Interventions in NHS Vending Services:

- Deliver strategic vision for their catering services.

Procuring and Managing Vending Service Contracts Compliantly:

- Product formulation;
- Pricing.

Providing Outsourced Vending Services:

- Wider changes to distribution;
- Use of the substantial purchasing power of the NHS to reinforce measures;
- Coordinate trade, food and agricultural policies with the protection and promotion of public health;
- Gather baseline data about providers.

Vending Machine Point of Sale:

- Clear information and labelling;
- Use of traffic light food labels in vending machines;
- Marketing;
- Healthier food and drink and less unhealthy food be promoted in non-patient food like retail and vending;
- Healthier food and drink and less unhealthy food be made available in non-patient food like retail and vending.

Vending Customers Consuming Goods:

- Food and weight loss education programs;
- Targeted personal support;
- Encourage consumer demand for healthy foods and meals;
- Improve staff health and well-being (key stakeholders in vending service improvements).

(HFSP 2014, NHS England 2014, WHO 2015, DoH 2014, Marmot 2010)

This chapter sets out to investigate some of these areas of policy guidance and how potential changes have been, or are yet to be, tested, at Barts Health, at an NHS, public sector, national and international level. By defining what work already exists and areas still to be tested the research can identify its main contributions to knowledge. Each potential change, and at each level, may have its own unique dilemmas and even be tangential to global dilemmas. Baselining the policies and research publications, and understanding the 'shop floor', was essential to what work had already been done and where work was most immediately required from the Barts Health perspective.

Review of wider policy approaches

The changes in NHS retail catering are new and largely untested. In comparison, educational settings in the UK have a long history of formal inquiry, and this might provide insight (Nice 2016, WHO 2006). Soft FM and retail companies, policy implementation organisations and researchers work across both sectors, adding weight to this idea (FFLP 2016, fyfv 2014). Furthermore, service evaluation methods can be appropriated and adapted, especially where there are no other available methods developed given that the focus in healthcare is comparatively new (Kelly et al 2012).

The levy on sugary drinks is one example of a public health initiative that impacts vending services that began in schools. Research in schools has yielded unpromising results: it has no impact on BMI nor a consistently positive impact on healthy choice (French et al 2001 and 2011, Powell and Chaloupka 2009). This suggests caution should be adopted in appropriating such methods in NHS retail.

To consider the best potential approaches for the NHS retail sector, other more overarching approaches can be compared from education. In both France and the US, there have been differing approaches to public health in school catering that can be considered in light of vending in the NHS. The approaches taken by France and the US in schools offers a starkly contrasting potential government approaches (Phillips et al 2003, ten Have et al 2010, Terry-McElrath et al. 2014, Chauliac and Hercberg 2012, Capacci et. al. 2012, Dubuisson et al. 2012, Martin and Chauliac 2014). The two strategies both build on the empirical evidence of the impact of vending services on health (Ermetici et al 2016, Kelly et al 2012, Maliderou et al 2006, O'Hare 2015, Almeida et al 2014, Gemmil and Cotugna 2005, Capacci et. al. 2012, Chauliac and Hercberg 2012, Mesas et. al. 2012, Muñoz-Pareja et. al. 2013, Martin and Chauliac 2014).

In the US, as in many other countries, the common measure of a poor diet is BMI and obesity, which has specifically been linked to the presence of vending machines in schools, with a focus on low income demographics (Gemmil and Cotugna 2005, O'Hare 2015).

Act 1220 is the main policy guide to public health and catering in schools in the US, advising that schools should:

- Weigh children;
- Implement mandatory sports classes;
- Restrict but not prevent access to vending (to protect commercial interests and revenue).

(Phillips et al 2003, ten Have et al 2010, Terry-McElrath et al. 2014)

These types of interventions focus on decreasing the BMI of the overall population. This approach is questionable, as it does not acknowledge why or how children might have become fat.

In contrast, France, takes a preventative, long-term approach to policy on school catering and public health through the 15 year-long French National Nutrition and Health Program (PNNS) which began in 2001.

The programme's main aims included:

- Ban vending machines in schools 2005;
- Proper meals without unhealthy snacking. Lunch attendance in French schools has been associated with healthier overall eating habits and less sedentary behaviour such as vending machine snacking;
- Encourage physical activity;
- Education and provision of information;
- Make healthy choice easier;
- Improve food and the physical environment;
- Ban the stigmatisation of eating habits, address eating disorders;
- Define the word nutrition;
- Focus on nutritional quality by 'providing products with low energy density and high nutrient density (e.g., fruits, grains, a variety of breads, dairy products without added sugar or fat, fruit juices)', which started in 2009;
- Take an evidence-based approach;
- Adopt a complex inter-ministerial and inter-sectoral approach, to ensure the holistic approach to public health is achieved.

(Ungureanu et al 2014, Chauliac and Hercberg 2012, Martin and Chauliac 2014, Dubuisson et al. 2012, (French ministry of health 2012).

Capacci et. al. (2012) performed three forms of statistical analysis to compare pre- and post-nutrition surveys from before and after the vending ban in France. Acknowledging the difficulty of linking such a change with people's health, the research suggested the vending ban had a small yet significant impact on the fat intake of adolescents (Capacci et. al. 2012). Other reported changes since the PNNS have been reduced salt, meat, alcohol and sugar intake at a national level, increased and sustained consumption of fruit, and a levelling off, or decrease below other European countries, of obesity in children (Chauliac and Hercberg 2012, Martin and Chauliac 2014).

The guidance from both countries approaches to healthier catering in school systems partially echoes UK policy for NHS catering, and suggests potential ways that this guidance might be furthered. In comparison with these approaches, UK guidance for NHS catering is often voluntary and has yet to be tested. Like the US, the UK has decided not to ban vending all together, and so intermediary measures must be the focus here. The level of policy guidance in

vending services in healthcare is currently low (Skov et al 2013, Hua and Ickovics 2016). This leaves scope for potential improvement to the existing, closely aligned literature about education systems.

Later, when reflecting upon the results of the primary research, an important aspect of discussion will be to understand how the findings might be incorporated into government policy. The two approaches discussed here offer some frame of reference to the different possibilities

Key considerations of health in policy communication

Given that policy guides on vending in the NHS are evolving, there is fundamental work to be done in deciding the best and worst approaches. Delivering policy guidance through catering services, for example, requires agreed standards of what can be termed healthy, and the different options will be evaluated throughout this chapter. This is a deceptively complex challenge. Despite political pressure and guidance for improved public health, and healthier NHS catering services including vending, there is continued debate over how to develop policy guides that ultimately improve people's diet in the NHS and little vending-specific guidance with defined nutritional standards (DoH 2014, Boorman 2009). This is despite the fact that the negative impact of the kinds of unhealthy food products sold in vending machines has been regularly mentioned and acknowledged in these debates (WHO 2015, Nice 2016, Nice 2015, the NHS England 2014, NHS England 2015, HPH 2015).

Policy guides can be ambiguous as there is little specific guidance on what 'healthy' is or regulation about how to make improvements to vending in the public sector specifically (WHO 2015, Nice 2016, Nice 2015, The NHS England 2014, NHS England 2016, HPH 2015, Boorman 2009). The situation is similar in the US (Winston et. al. 2012). Products deemed 'healthy' might in fact be less nutritious than traditional ones in some cases. For example, baked crisps may contain more sugar than traditional types, and fruit juices can contain as much or more sugar than traditional fizzy drinks (Centers for Disease Control and Prevention 2014).

Nutrition is mentioned 32 times in the HFSP report section on patient nutrition and hydration, but only four times in the healthier eating, and five in the sustainable food and catering services sections. These latter two sections, with less discussion of healthy eating, essentially cover FM services and vending. This suggests that that healthy eating is not central to food and drink strategy in non-patient catering and that good nutrition is not a fully integrated concept across the policy approach to NHS catering service delivery. Approaches to areas of non-patient catering like vending are likely to lack clear standards for FMs to follow as will be proven later in the chapter. This is a problem as Barts Health must close the policy gap between guidance and delivery, and demonstrate how best to deliver change in vending.

A key output of this research will be to evaluate existing definitions of healthy and assess how these might be worked into the service at all levels. This section has already addressed the first area to be looked at: policy. While terms such as healthy are ambiguous in policy guidance, several options for service improvement have been put forward in the policy documents discussed so far. Following on from this guidance, the rest of the vending service system must find ways to deliver the guidance, to be awarded CQUIN funding opportunities, maintain compliance, and produce an effective soft FM contract for vending service. Through the related literature, the rest of the chapter will continue to evaluate how service might be improved across vending services. Strategy, discussed next, is the key piece of communication that moves from policy advice to the Trust level of improvement through operational management systems.

There is a policy gap because the reports on healthier lifestyles do not tell Trusts how they should deliver change. FMs and other delivery teams such as the public health department at

Barts Health must find ways to meet policy on their own. Taking this gap into account, the next section looks at literature on strategy development at organisational level and the different potential approaches. Creating strategy is one of the core objectives that Trusts must meet for food and drink services across the NHS. The primary research questions, exploring interventions that promise to deliver positive change at the point of sale, and the survey which offers an understanding of the end user demands and opportunities for service change, will inform the way Barts Health and other Trusts deliver the necessary changes at an operational level. These insights will be directly linked to the policy demands of catering service improvement and public health.

3.3 Defining strategy

Among many recommendations for improvement, policy guidance recommended in 2014 that NHS trusts should deliver a strategic vision for healthier catering services (HFSP 2014, NHS England 2014, WHO 2015, HFSP 2014, DoH 2014, Marmot 2010, Sustain 2015). This researcher represented the FM team in a cross department senior management working group to produce the Trust's first food and drink strategy, and provided formal reflection on the strategy development process (DoH 2016). As a result, the strategy incorporated the insights from this research, especially the results from the end service user survey. The key decision-makers for catering were represented by dietetics, public health, and FMs. This experience revealed the potential for strategy as a piece of communication, to best improve catering services in the NHS and how using end service user feedback was vital to evidence that the Trust's vision was supported by staff, and that it listened to their needs.

A strategy document is a communication tool that enables new ways of thinking and ways of using information to guide and create patterns of decision making, as well as capturing a vision for the organisation in a clear and consolidated form (Brown 2010, Lee 2014, Mintzberg and Waters 1985 Johnson and Scholes 2008) In the public sector, it is both a public and internal document and must align with changeable political leadership within powerful bureaucracies that resist change (Rose and Cray 2010, Bichard 2013, Boyne and Walker 2004).

Social and financial expectations of value for money and a host of stakeholder needs are also characteristic of public sector strategy that can constrain services and lead to rigid management frameworks, limiting the managerial discretion needed to execute strategy (Boyne and Walker 2004, Rose and Cray 2010, Brown 2010). Government organisations are reportedly less equipped to deal with non-routine and nonstandard service challenges, which ties in with this view of strategy development in the public sector (Head and Alford 2015).

Out-of-hours catering for staff and vending services is a good example of a service area that can be described as difficult to standardise, non-routine and a non-core element of catering services. It requires strategic vision to foster improvement, but one that aligns with the entire catering service.

Deliberate and emergent strategy development

To develop a strategic vision, public policy in the UK since 2000 has become increasingly reliant on interaction with organisational stakeholders, such as Barts Health, to co-create strategies that can act as delivery mechanisms for centrally designed changes (Oborn et al 2011). This includes planned changes to catering and vending, requiring an evolutionary interaction between stakeholders and an overarching centralised design (Oborn et al 2011, Mintzberg and Waters 1985).

For NHS catering, including vending services, the deliberate, centralised element in strategy development is the Department of Health *Toolkit to support the development of a hospital food and drink strategy*, in line with the HFSP and main regulatory body for the NHS, the Care Quality Commission (CQC) (DoH 2016). It asks trusts to address:

- The nutrition and hydration needs of patients;
- Healthier eating for the whole hospital community, especially staff;
- Sustainable procurement of food and catering services.

This is the same as the focus of the HFSP guide; the second and third sections are most relevant here. Of the guides mentioned in the Toolkit, the two guides that are of special interest in vending are:

- For staff and visitor catering: *Healthier and More Sustainable Catering – Nutrition Principles* (Public Health England 2014);
- *GBS for Food and Catering Services* (DEFRA).

The relevance of the GBS has been explored in relation to the guidance on vending. Earlier it was asserted that the GBS standards allow one to classify vending products as snacks, and so this section from the *Healthier and More Sustainable Catering* guide on snacks is, by the same standards, applicable (DEFRA 2005). The guide gives target recommendations in % (PHE 2014):

Percentage of daily intake					
	Energy Protein Fibre	Total fat, saturated fat, sugar, salt		Vitamins and minerals (where insufficiencies are apparent)	
Snacks	20%	20%	No target	*	No target
Total	100%	100%	98 or less	100	100 or more

target for nutrients where excess or insufficiencies are apparent.
* Snacks will provide additional micronutrients to contribute to the micronutrient target of 100% or more over the day. You should take care not to encroach on maximum safe levels of intake.

Figure 11 *Healthier and More Sustainable Catering snack guidance* (PHE 2014)

The guidance in Figure 11 would likely be used to communicate to staff and others, rather than setting service standards, as it reports on individual intake. It is, therefore, more useful as an educational tool for staff.

The problem with using the guide to educate people about vending and snack consumption is that if excess consumption is apparent (presumably this means if the individual is obese although it does not specify), then there is no set target % for how much one should consume from snacking. There is also no target for vitamins and minerals (PHE 2014). This means staff who display apparent 'excess or insufficiencies' cannot be given measures of how much they should be snacking using the guide. Another complication in interpreting the guide is that, compared to the GBS, the standard is in % of individual intake, rather than per 100 grams or millilitres, making the standard harder to align with service standards.

Where there were unanswered questions in the guide, Barts Health and other Trusts have to develop approaches by reflecting on the needs of their individual Trusts and the catering services within them. The toolkit enables public sector management to derive their own strategic planning (Schedler 2004). Deliberate goals can be set, complementing pre-existing practices, and the existing guides and processes in place can also be disseminated and affirmed.

Using the DoH toolkit, Barts Health developed its own strategy, using a formal strategy working group. Formal groups, characterised by their cohesiveness across departments, are critical to producing a successful strategic vision for the Trust (Mullins 2010, Rose and Cray 2010). Senior management from FM, dietetics and public health participated, and this researcher represented the FM department in the working group. This was a piece of operational field work and a unique opportunity to reflect on and learn about the strategy development process tacitly which enriched the end result of the research.

The food and drink strategy development process was unique at Barts Health for several reasons. Primarily, having searched for published strategies, only 10 were found using google, suggesting that not many Trusts have completed and/or published their strategies. Barts Health has a dedicated department of public health who directed the strategy development, which is unusual in an NHS Trust. Strategy development was also unique as it was happening at the same time as the soft FM tender, and so it was hoped that the strategy would directly inform the tendering process. The results of the staff survey, conducted through this research, were used directly in the strategy document, as well as the results of the work done to evaluate the DEFRA GBS. Finally, the strategy development process was unique at Barts Health as this researcher was also a dedicated resource, whose work and input enhanced the capacity to reflect, engage with FM meaningfully and increase the data gathering that informed the vision.

Looking at 5 other anonymous NHS food and drink strategies highlighted the uniqueness of Barts Health's strategy:

Hospital Trust	public health department in the Trust	Primary research used	Retendering within one year of publication	Supply chain engagement used other than GBS	Cross department input	Mention of vending	Mention of GBS	Mention of wider community
Barts	Y	Y	Y	Y	Y	Y	Y	Y
A	N	N	N	N	N	N	Y	N
B	N	N	N	N	N	N	Y	N
C	N	N	N	N	N	Y	Y	N
D	N	N	N	N	N	Y	Y	Y
E	N	N	N	N	N	N	N	N

Figure 12 Comparison of a sample of NHS trust food and drink strategies with Barts Health

Vending was only mentioned by two other Trusts and supply chain engagement was achieved through GBS. However, no evidence given as to the achievements and the GBS is in a developmental phase. Aside from showing how unique the development process was at Barts Health, this table also supports the earlier assertion that public sector organisations have limited capacity to develop in-depth, personalised, or meaningful strategy.

Having reviewed the potential for strategy development, as well as the reality for many organisations such as Barts Health, it is clear that organisations have limited capacity to succeed in this area. Without a clear plan for improvement guide by a policy-driven vision, it is difficult to see how improvement can be embedded and suggests that vending lacks strategic vision for improvement across the NHS.

The review shows a need to test interventions such as the primary research done in this project at point of sale. This ability to produce knowledge in the formation of strategy provides a bottom-up approach with robust data about what interventions work. Using primary research

in strategy development will make it possible to populate a strategy with meaningful targets and, in the process, find measures that are appropriate for capturing public health agendas. It is equally important to provide a baseline of opinion and current service demands that enables strategy to respond to people's concerns and needs to understand the gap between service and service expectation.

Strategy being the first area addressed for improvement, the second key area for improvement suggested in policy guides is gathering supply chain information and engagement. Supply chains determine the product delivery and inherent service design. The next section considers the industry standard for supply chain engagement in vending service improvement. Both exercises in strategy development and supply chain engagement are examples of the key communication required for service improvement.

3.4 Supply Chains and Service Contracting

Limited mention of vending was found in supply chain improvement tools. This is a problem, as these tools are the industry standards for creating transparency across supply chains and so their approach to vending is also the industry standard for embedding vending service improvement across the supply chain.

This researcher conducted design and consultation work in the course of this project, with supply chain auditors, the Sustainable Restaurant Association (SRA), to pilot a commercial audit at Barts Health catering that could be used nationally across the NHS. The tool was being recommended by government for national use across the NHS. The researcher coordinated the audit and feedback over a space of a year. It is not directly related to the primary research in this project but it helped to highlight the current state of the art in catering supply chain auditing, a vital communication tool in service improvement for vending.

The researcher also acted as consultant to the Food for Life Partnership (FFLP), meeting with both groups and reviewing their questionnaires and guides in light of supply chain interviews. This researcher project managed the SRA audit at Barts Health, gaining invaluable insight into the efficacy of using such auditing approaches, as well as having influence on their final designs.

Audit	Vending question/criteria in the supply chain audit
SRA	Do you have a vending policy in place to promote healthier eating options for staff, visitors and patients for e.g. unsalted nuts, fresh fruit, and unsweetened drinks (please provide evidence)?
FFLP	Consistent messaging and prominent availability of healthy food throughout the hospital, including access to good food out-of-hours .

Figure 13 Vending specific questions in the SRA and FFLP audit

As with policy documents discussed earlier, these auditing tools use words like 'healthy' and 'snack' but do not define these terms adequately. The term unsweetened is also ambiguous in this particular excerpt.

As a piece of communication to link with the supply chain, both questions are open-ended, and difficult to connect to service improvement. The positive of this is that it leaves the caterer free to give substantial response. The negative side is that, given the open-ended questions that auditors ask Trusts regarding vending, there is a large gap in which to decide the best course of action, and uncertainty about how to evidence this meaningfully. FM teams are the gatekeepers

to service delivery mechanisms, data sets, permissions, and resources that allow for a meaningful change in the supply chain and this varies from Trust to Trust. They need to be asked questions that guide them in what to be focusing on when making improvements. As the link between policy, strategy, and the supply chain, there is not enough guidance available in these audits to help Trusts make positive improvements. Given the level of uncertainty within the supply chain, one must consider the reliability of data being shared by various stakeholders too.

The next section looks at another critical piece of communication in service improvement: contracts. These are especially important in Barts Health, where the service was being retendered. Much of the work done was to engage applicants with current policy and with Barts Health's vision for catering. This is vital to ensure opportunities for improvement are enforceable, and the Trust has mechanisms to effect change in outsourced contract structures.

Obtaining audit ratings is a way to certify that the Trust, and any NHS Trust, is meeting their obligation to improve vending services as part of wider catering improvements. There are funding opportunities created by the capacity to achieve such audit standards, but no guidance how to engage supply chains or achieve service improvement, or what approaches should populate Trust-level vending policies. As with strategy development, and the capacity to meet policy agendas, primary research will enable a content and evidence-driven approach to meeting audit demands. It also ensures that the meaning and intention of public health improvements set forth in these communication tools is delivered. The primary research ensures that approaches are embedded, proven and connected to the end service user.

3.5 Context: Contextualising the design of vending machine point of sale

This second half of the literature review is centred on the service user. In developing new methods of service improvement through communication, both through research and in operational practice, demographic information about the intended users, the contexts and processes within which data will be collected and or shared, as well as the aesthetic choices about how to represent data to people, are the central factors in determining the appropriate methods and resultant impact of communication.

Government policy guidance advises, among other initiatives, that at point of sale, clear information and labelling and use of traffic light food labels in vending machine services might aid service improvement (HFSP 2014, NHS England 2014, WHO 2015, DoH 2014, Marmot 2010). As well as evaluating the kinds of labelling techniques that one might wish to employ, this research also views the matter as an essentially context-driven research problem, focusing on the broader goals of encouraging healthier choices. There are also many wider methods associated with the design of the point of sale environment influencing users and customers.

There is much existing research that tries to understand and quantify the environmental and contextual aspects of communication in the built environment, asking how designs are actually being used and influencing user behaviour. Intuitively, the context within which designs are used can greatly influence the way people use them, and their perceptions of designs (Thaler and Sunstein 2008, Sterman 2000 p.537, Lockton et al 2010, 2008). Among other research fields, FM researchers have called for greater consideration of the environmental factors that can influence design (RAE 2016, Nenonen and Sarasoja 2014, BIFM 2013, Martin and Guerin 2006, Coenen and von Felton 2014, Mclennan 2004).

Theories about Nudge or choice architecture, Harmonic Structure, Space Syntax, and Designing with Intent are the wider theories dealing with ideas about the design of user environments

discussed in this section (Thaler and Sunstein 2008, Sterman 2000 p.537, Lockton et al 2010, 2008). They will be summarised in turn.

Choice architecture operates on the assumptions that people's behavioural preferences can be influenced by redesigning the environment using a range of technologies in the context in which they make their choices (Thaler and Sunstein 2008, Skov et al 2013, Terlutter and Capella 2013, Darby 2006). Incentives are also discussed in Nudge Theory in terms of the value they add to an option, although they differ from 'nudges', as they are interpreted cognitively, they are part of the persuasion process. Nutritional labelling is one example that was tested in the primary research.

Designing with Intent uniquely incorporates product design theory, treating computer science-based communication technologies as physically present and used objects (Lockton et al 2010, 2008). This echoes the attention paid in the primary research towards the installation and engagement with stockists to ensure the experiment was fully implemented with minimum error.

Space Syntax describes how people move within the built environment, as a performer among many, sharing a collective pattern of behaviour, and the social significance of space, given its structural properties (Fata gen. Schiek et al 2009, Fata gen. Schiek et al 2008, Schnädelbach et al 2007, Schnädelbach et al 2006, Hillier and Hanson 1989, McCarthy and Write 2004). These ideas were used to differentiate the spaces in the experiment. For example, most and least busy areas, either with a high or fast flow of people, or slow moving areas such as waiting rooms, were differentiated in the analysis.

Closely related to Space Syntax, Harmonic Structure Theory is interested in user-centred, Vitruvian proportions of design in architecture and computer science, using Laban's theories of movement, which were originally developed in fields of dance and choreography (Spier 2005, İnce Güney 2014, Al-Sayed and Fatah Gen Schieck 2013, Vinayagamoorthy 2006, Lavie and Tractinsky 2004, Gao et al 2012, Longstaff 2000, Fagerberg et al 2003, Sundström et al 2007, Sutil 2013, Grabska 1996).

An experiment in the dissertation portion of the research project considered screen placement according to the predicted eye line of customers, and where best to place staff behaviour change messages for maximum impact. The aim was for best opportunity for fixed gaze, determined by height and length of time people were likely to have to look at the screen. £2,000 was awarded to install screens for healthy eating messaging and energy saving messages as a result. Given that the project was outsided of the scope of the research question, it was not incorporated as primary research in the project. The project did however use observational techiques from space syntax and conclude that the speed at which people travel and the business of the location did impact their likelihood of seeing a message. Further information can be found in section 6.3 of the Dissertation in appendix B.

In this research, it is yet to be seen how these latter theories inform vending machine design, given that the focus in policy is on nutrient labelling and choice architecture (Skov et al 2013, Hua and Ickovics 2016). The interventions at point of sale in the primary research will incorporate variables of the context in which vending machines are located and use the design to encourage healthier choices. This will relate to theories such as Nudge and Space Syntax. The next section continues with the discussion of the point of sale environment and the role of different communication techniques and technologies. Ideas about space syntax, and the context of the point of sale will be reflected on further in the design of the labelling interventions.

3.6 Aesthetics: Aesthetics and communication tools at the point of sale

Models of communication rely on 'a conceptual structure of abstractions, formulated initially in the mind of one of the persons who would communicate' (Licklider 1960). Meaning is revealed through chosen modes of representation and this applies to the visual layouts, tone of voice and choice of colours that make up models. If the 'mind of one would-be communicator are very different from those in the mind of another, there is no common model and no communication' (Licklider 1960, Cohen and Bailey 1997, Coakley et al, Erb et al 2009). Policy focuses on labelling as this is viewed as an essentially aesthetic choice, meaning that the appropriateness of how one designs labelling and implements it at the point of sale can influence people's perceptions.

The research question asks specifically about labelling, given the policy focus. However, there are many more trends in end service communication technologies that could be considered by policy makers, within the context of point of sale environment designs. New research in communication is focused on big data, virtual reality and real time feedback and is equally impacting the way data is being represented (Brewer et al 2011, Rittel and Webber 1973, Brid and Rodgers 2010, Chen et al, 2006, Kjeldskov et al 2012, Koblin 2014, Milton and Steed 2007, CERC 2017, Nicholson- Cole 2005, Okunlola and Ewulo 2013, Stock et al 2011, Carbon Visuals 2012, Schnädelbach et al 2007, Behrens et al 2013, The St George 2008, Clegg 2000). The focus from the developer perspective is often about how to get users to adopt new technologies (Bannon 1991, Kim 2003).

One approach to designing the aesthetics of communication is to aim to evoke emotion and influence users, a practice professionalised by marketers (Terlutter and Capella 2013, Darby 2006, Lurie and Mason 2007, Cairo 2012, Fillis 2009). Training videos, and informative adverts and posters, fall within this side of the communication spectrum too, and are often used in organisational management practices. The government public health guidance shows this softer, more marketing-based approach. The Public Health England (PHE) Eatwell Plate for example:

Figure 14 *PHE Eatwell Plate* 2014

This is useful to individuals deciding on a balanced diet, and is a common piece of communication used in public organisations as an educator for end users. It can be displayed at the point of service use and it is also mentioned in the report on Healthier and More Sustainable Catering (PHE 2014).

At the other end of the communication spectrum, aesthetics can be designed to ensure that 'work is always rooted in data' and to ensure that 'the character of data should have an impact on its visual shape' (Tufte 2001, John Turkey in Komor et al 1998, Almond et al 2000, Gelman and Shirley 2011, Chaudhry and Feest 2011, Hansberg 2010, Fan et al 2012, Cairo 2012, Fry 2008, McCandles 2009, Luke Jerram 2011, Philips 2011). This approach is reflected in retail package labelling for nutritional information. The FSA provides a guide on sugar, salt, saturated and unsaturated fat that is adapted for this purpose:

Figure 15 *Food Shopping Card* (FSA 2005)

Variations of this guide are often printed on food and drink packaging and other public health guides. This data-driven guide for labelling also forms the basis of the GBS guide for snacks, presented earlier (which is set below 'high' according to FSA guidance). It also appears at the top left of the Eatwell Plate (Figure 14).

The choice of representation of information presents the inherent uncertainty in different systems being represented; unknowns about the intended user, and incomplete data sets are all factors to consider in the different potential modelling and aesthetic techniques that one might choose (Chiu et al 2009, Dong and Hayes 2011 and 2012, Tang et al 2014, Rangavajhala et al 2009, Kanukolanu et al 2006, Bonissone 2007, Naim et al 2008, Lotov 2007 and 2009, Palomares et al 2014, Diehl et al 2010, Deitrick and Wentz 2015, Deitrick and Edsall 2006, Ferreira et al 2014, Köpp 2014, Tufte 2001, Daradkeh et al 2010, Fleischhacker and Fok 2015, Frizelle and Woodcock 1995, Bonissone 2007, Coakley et al 2014, Sterman 2000 p.537). A key issue in dealing with uncertainty is to check underlying assumptions in data. Supply chain audits, for example, are one method by which one can reduce and capture uncertainty in service improvement (Schedler 2004, Rose and Cray 2010).

There is a gap in the literature about how reduce the uncertainty of how to redesign the aesthetic of vending services, as well as the uncertainty around end service user behaviours. The current user opinions and the ways the service meets their demands also need to be clarified to show if people how people feel about the current service. Understanding how best to intervene in the point of sale intervention would reduce uncertainty about how to operationally deliver positive change to labelling, checking if interventions deliver significant improvements. To achieve this, sales data is required as evidence. Understanding and communicating end service user behaviours would achieve a reduction in uncertainty about how to design service.

3.7 Support for across-the-board nutritional profiling in product labelling for vending

Although there are many industry standards, finding appropriate labelling for vending is difficult as customers can't pick up and look at the information usually printed on the back of products. Even printed information can be absent, as product manufacturers were only voluntarily required to use nutrient labelling before December 2016 (unless a request was made for information, when making a health claim, or when minerals and or vitamins were added) (FDF 2013, FSA 2016). This means that finding nutritional measures of improvement that focus on public health is a challenge.

For vending, a summary of information is needed to achieve effective labelling, given that people cannot see the back of packet. With limited space on vending machines to display information, easy to understand summaries are critical to communication. Nutrients would have to be combined and given a new summary of their nutritional properties, a process termed across-the-board nutritional profiling.

Across-the-board nutritional profiling allows each product or dish to be given a score based on its nutrients, and this individual value can then be compared to other products quickly and easily. In this research, products could then be split up into red, amber or green to show least to most healthy, just as the FSA currently do on packaging. This is the first time that this profile has been adapted in this specific way, in a healthcare setting for vending, and with the rigour of a method and suitable analysis, although many other closely related applications exist.

Examples of across-the-board profiling can be seen in the US (Healthy Eating Index 2010) and many other countries including the UK. The most prominent profile used in the UK, and internationally, and in healthcare settings as well, is published by the FSA and Ofcom, the UK communication regulator.

Developing across-the-board profiling involves combining and weighting nutrients, requiring large amounts of expertise and consensus. This expert work was achieved by Mike Rayner et al. (2005). It was developed in consultation and through working groups with a panel of dieticians across the UK. The British Heart Foundation coordinated the work in collaboration with the Department of Health and the FSA, which reinforces that there is a vital link between cardiac health and diet. The publication by Rayner et al (2009) gives a copy of the profile in full.

The Rayner model has been used in public health campaigns internationally, in countries such as Australia and France, in World Health Organisation campaigns, as well as in a specialist NHS Wales vending project (although this was not a formal piece of research) (ANSES 2015, Jewell 2008, Sloane 2014, Bolton NHS Foundation Trust 2010, Rayner 2014, Rayner 2013). All report favourably on the profile. However, none have produced an experiment that tests it as a vehicle for point of sale vending labels, and not in healthcare. This means that the profile is well suited to this research problem but remains untested, and therefore the research makes a novel contribution to the development of the application of the profile.

The profiling was originally developed to be used by Ofcom in defining 'healthy' and 'unhealthy' foods and drinks for TV advertising to children. Like other examples of nutritional profiling in US healthcare, the Ofcom model has been taken from work with young people and children and since been widely adopted in public health initiatives (Winston et. al. 2012). This may indicate a methodological flaw in the profile. However, being the best method found by this researcher for across-the-board profiling, and having been applied in many different relevant examples, it was still used in this research.

The system allows one to add up values of different nutrients in each product per 100ml or 100g, then assign a final score for each product. Products in grams and millilitres are ranked separately. The system takes into account both positive and negative nutrients, fat, sugar, salt, fibre, protein and others.

There is cause to believe that adopting an across-the-board nutritional profile is ideal for vending. Having developed this approach, the research can base the communication interventions at the service user interface on this profile, combining it with other insights such as those offered by Nudge Theory (discussed earlier in this section). The end service user interventions involved collecting sales data and trialling a range of approaches to encourage healthier choices, and will be discussed further in the Method chapter.

The insights from this primary research may inform the entire vending system. This because at the beginning of the project it was unclear if the profile would be useful in other areas of the research such as contracting and supply chain, and setting SLAs. Reflecting on nutritional profiling was also useful in reviewing where in policy, contract, strategy, and supply chain audits improved definitions of terms such as healthy could be made.

By using the profile to create nutritional labels for the point of sale interventions, this research will find out if the model is effective at the most important level of operational service delivery to positively influence behaviour. This bottom-up approach to developing appropriate measures for service improvement ensures that end users and public health are central and can then be used to build up control throughout the vending system.

3.8 Conclusion

This chapter has highlighted much of the communication within vending services that can effect improvement in healthcare. By reviewing this literature, and linking it with first hand experience in the sponsor company, many of the primary research decisions have emerged organically. For example, the support for accorss the board nutritional profiling has emerged with a strong likelihood of inclusion in the primary research design for point of sale labelling. The review of government guidance has indicated the need for more detailed information collection about service in use, and so a survey of survey users would be an ideal way to meet this demand from government.

The primary research approaches the research problem by focusing firstly on the end service user through the large-scale survey and secondly on designing point of sale to influence choice. Both are concerned with the user behaviour from the perspective of service controls and measurements. This chapter has linked the literature about the vending service as a system to these activities, focusing on the policy, strategy and supply chain auditing and contracts in place, and viewing them as pieces of communication.

The chapter has discussed work ongoing to combat the negative impact of the kinds of confectionary and crisp products sold in vending machines, and highlighted ways in which the NHS is incentivising and supporting healthier behaviour in the context of preventative healthcare measures and a concern for staff health and well-being currently (NHS 2016, Marmot 2010; NHS England 2016 b., WHO 2015, Nice 2016, Nice 2015, The NHS England 2014, NHS England 2016, HPH 2015.b). A gap was found between these pieces of communication and FM and operational practices.

Linking the related issues of public health and healthcare costs directly to issues such as catering procurement decisions, or the presence of vending, is complex and requires the establishment of measures and controls that the primary research will contribute towards (Gase et al 2011). It is also vital in order to encourage service improvement in a scenario currently driven, measured and controlled by economic factors rather than by public health, to evidence and pre-empt change.

The chapter moved from government policy down to end service user issues in vending service improvement. The focus was on a range of topics, including overarching trends in end service user research, behaviour change research about new techniques and technologies of communication, the public health agendas in vending, and nutritional profiling and policy approaches.

Areas of potential improvement have been identified too, and are listed in Figure 16:

Several areas of potential improvements to high level advice were revealed:
Fostering a resilient service to cope with changeable government agendas
Internal departments working together
Addressing both public health and economic concerns
Providing economic justification for service change
Providing nourishing products
Well defined SLAs and KPIs in contract design
Informing and educating FMs about public health agendas
Informing contractors about public health agendas
Accessing commercially protected data
Accurate timely data collection, monitoring and analysis
Design effective product labelling
Design effective purchasing environment fit for purpose, which is out-of-hours retail for staff
Catering for individual needs
Improving staff performance
Improving eating habits
Catering for the demographic using machines

Figure 16 Areas of potential improvements to high level advice for vending service improvement

Encompassing these issues is the need for clear definitions of measures so that service providers can and control and redesign service and make necessary improvements accordingly. Guides such as the GBS offer partial answers to service improvement, control, redesign and standardisation. Techniques and technologies were discussed that might fill the gaps and be tested in the course of this research to help FMs deliver operational change.

Nutrient profiling was a central aspect in this chapter and across-the-board profiling was decided as the best point of sale intervention and measurement method to be used in the experiments that followed. The primary research can support the guides and policy reports to help improve vending by testing potential delivery options in healthcare vending, and there is little existing knowledge in this area given how recent changes are. The suggested labelling method was trialled and the research design discussed before testing the approach and reflecting on its usefulness.

The second piece of primary research carried out was the collection of end service user feedback. This made a novel contribution to vending service improvement literature in the NHS for staff, as there was little formal collection and analysis of end user opinions available in the literature and it was invaluable in strategic service planning. Understanding the appetite for

service change, and the current capacity for staff to make healthy choices, is key in understanding what measures will increase their capacity to act. It might also illuminate commercially attractive opportunities where service might be redesigned around underlying demands for more retail out-of-hours.

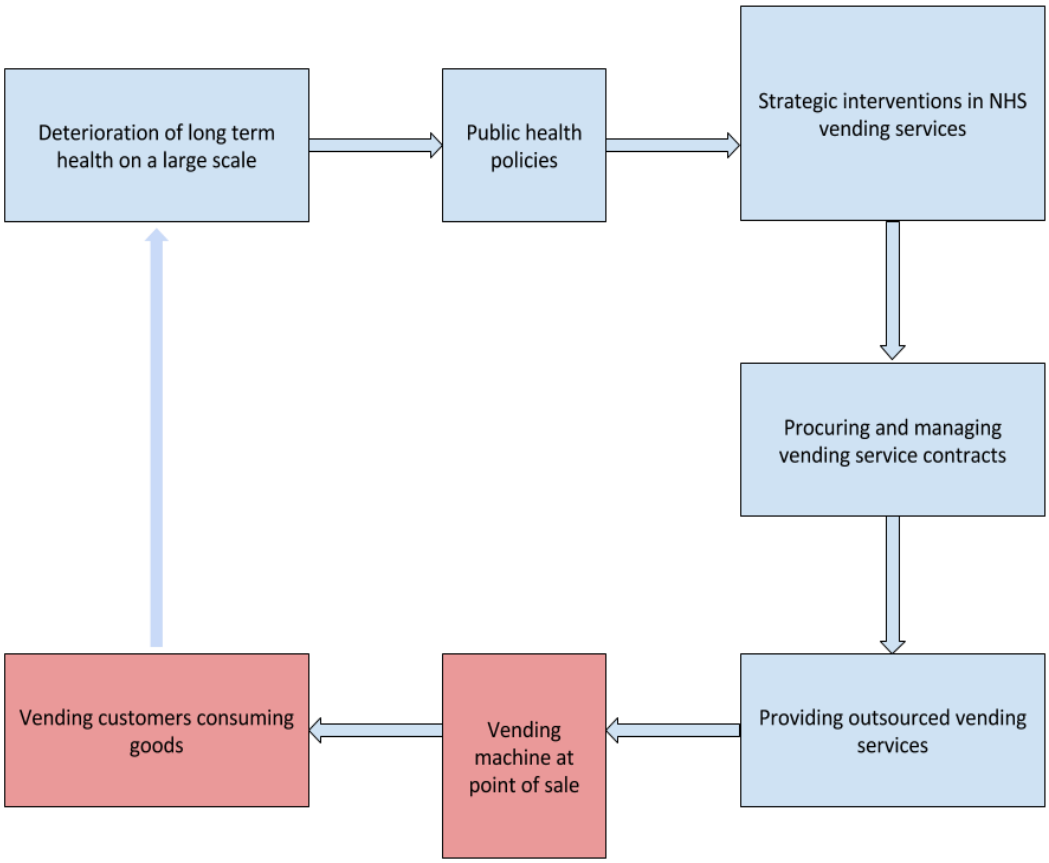
Through the two pieces of primary research, the project links advice and governance to practice and operational management. The findings will be valuable in each of the key communication documents in vending, policy, audit tools and contracts.

Chapter 4 Method

4.1 Method Introduction

This chapter explores the research approach and design of this project, and outlines the main research activities, as well as covering some of the adjacent research approaches.

In the previous chapter, it was revealed that aspects of communication regarding government public health policies, strategic documents, contracts, audit of outsourced vending providers, vending machine point of sale and communication with consumers consuming goods were all areas where the primary research could offer insight and aid improvement.



In all areas for example, the literature review revealed that more clear guidance about how to make changes in service and define healthy and unhealthy foods was needed. Guidance was needed that was uniform and easy to understand and apply.

Aspects of strategy development, contracting, the development of a strategy at Barts Health was one of the key outcomes that the primary research sought to positively influence and inform. These were areas where the researcher worked directly with the trust on various informal research projects outside the scope of the thesis and built up an understanding of the requirements and opportunities for change.

The primary research will be discussed in light of these governance communication areas in the discussion section of the thesis. Little was known prior to this project as to whether FMs would be capable of integrating advice into service and service contracts within the current frameworks of governance. For example, UK guidance for NHS catering is often voluntary and has yet to be tested, suggesting complications were likely.

The need for clearer definitions of what is healthy was identified in the literature review. It was decided that the results of the primary research would be used to evaluate existing definitions of healthy and assess how these might be worked into the service at all levels.

This next chapter on methods seeks to better understand how such formal primary and informal research activities can be brought together in one project, and the different approaches that have had the same or similarly ambitions.

In this next chapter, discussion works from a high-level discussion of methodology, through the mixed methods design and some other potential approaches, down to the detailed discussion of approaches taken in each of the primary research activities. This research uses quantitative methods in the primary research. However, much of the supporting work, which has not been formalised through primary research, was equally important and would have naturally encompassed qualitative methods. A mix of in-depth first-hand experience working in vending services was combined with the opportunity to conduct primary research and reflect critically on the findings in a wider context. This combination of activities in the project created a unique set of tools and solutions that deal with the challenges faced by in-house service delivery teams delivering public health agendas through outsourced service contracts like vending, as well as contributing to knowledge through rigorous research methods at the end service user end. It is unusual for a hospital Trust to have a dedicated researcher to offer in-depth reflective thinking to add value to projects and cross-departmental working.

Several approaches are closely related to this research project and were discussed as potential methods. Given that industry demand preceded research design in this project, there was much reflection of potential methods, the ordering of methods, and areas of the project which took on differing methodological characteristics (Tashakori and Teddlie 2010). Mixed methodologies is the umbrella approach in which this kind of exploratory work is possible (Creswell 2013). The challenge will be at the end to reconcile the various populations into one set of observations.

The method of deductive logic, a top-down process whereby logically derived propositions or hypotheses are tested against observations (Ritchie et al. 2013 p.8), was used to design and implement each of the primary research activities, creating detail and methodological consistency to the data collection and analysis procedures. These were centred on service user feedback surveys and point of sale design and intervention to influence user purchasing behaviour. A nutritional profile was also used. Describing the methods of the primary research cases will take most of this chapter but first some consideration is given to the contextualising work that was carried out and the various approaches that were considered and ultimately not developed into primary research.

Inductive Reasoning

Inductive reasoning is a bottom-up knowledge acquisition process through which patterns are derived from observations of the world and is ideal in capturing and representing knowledge about an ill-defined research problem (Ritchie et al. 2013 p.2, Stove 1973). Inductive approaches are uncommon in FM research (Campbell 2017).

First-hand inductive knowledge was not analysed formally in this project and was peripheral to the central contribution to knowledge. It was, however, considered as informal research which greatly informed the project. Operational consultancy was undertaken in order to capture and embed the knowledge being generated throughout the research project and formal communication were contributed to. These included the DEFRA GBS, policy pack, food and drink strategy, new soft FM contract and industry-wide standard supply chain audits by the SRA and

FFLP. Much of this involved collecting and disseminating expert opinions throughout the NHS catering and public sector procurement system.

Informal inductive approaches were vital in scoping this research as little was understood about the service itself or the capacity for improvement at the beginning of the research, given that vending is a subcontracted, non-core service for which the Trust does not receive any profit. Secondly, it was a way to interpret how the research would impact the ecologies of the Trust. It was also a way to reflect on the research methods in the primary research with the main influencers, including service delivery teams, service users, those who have researched relevant aspects of the service, policy makers, contract teams and supply chain specialists (Crotty 1998). For example, deciding the nutritional model involved numerous meetings with Barts Health nutritionists throughout the point of sale experiment.

The Researcher

The role of the researcher was actively considered throughout the project.
In accordance with Tashakori and Teddlie (2010), the researcher was viewed under a transformative and constructivist methodological viewpoint, responsible for:

- Guiding the progression of the work to its final arguments and proposed solutions;
- Ensuring maximal reach to the intended audiences;
- Gathering expert opinion and first-hand experience into the research direction and insights;
- Testing the research assumptions and chosen approaches;
- Finding ways of feeding back the research findings;
- Influencing change and disseminating approaches;
- Delivering policies and organisational objectives in line with the research aims
- (Tashakori and Teddlie 2010).

The researcher can, from this understanding, be viewed as a legitimate, peripheral participant in the research; a learner, contributor, influencer, acting expert, and recipient of informal knowledge, acting within the research subject domain (Ritchie et al. 2013 p22, Tashakkori and Teddlie 2009, Lave and Wegner 1991).

The researcher went through the in-depth experience of working in the in-house facilities offices for extensive periods of time, two days per week for over three years and then intermittently for the remainder of this project, while the analysis and writing were being completed. This meant integrating into the team, taking regular site visits and attending department meetings in the operational hospital spaces, and getting to know the people using and delivering many facets of the service. Often the nature of jobs undertaken were far out with the research objectives. The research project managed the Christmas winter fair, commissioning local farmers and businesses, with a budget of around £7,000. The researcher also bid for and project managed a £20,000 charity-funded food education project in schools.

The reason the researcher undertook seemingly unrelated work in operations and dealt with the wider catering system was because it was a unique opportunity to have regular contact with core service providers and senior management. For example, in one memorable instance, while filming and interviewing the head of nursing at Barts Health for a staff training video on the correct disposal of needle sticks and sharps, the researcher assisted a patient who slipped into cardiac arrest while passing by.

The experience was not only personally rewarding, but also led to a trust between the researcher and the sponsor company, including free access to all buildings and areas, computer

systems, records, contracts, and to the subcontracted vending service operators financial and stock recording systems.

Ways to formalise first-hand experience in qualitative research traditions

With more time and resource, the next stage in this research would be to formalise the informal scoping and consultancy work conducted as part of this research. Several approaches are closely related to the inductive elements of the research approach, drawing on qualitative research traditions (Patton 2015). Given that industry demand preceded research design in this project, it took some time to arrive at a methodology and there was much reflection on potential qualitative methods so a short description of each is given here.

Grounded theory uses induction to build complementary methods to create in-depth understanding of the 'real world'. It is an attempt to capture a rich body of professional practice, and the in-depth knowledge of practice, and avoiding top-down theoretical constructs (Ritchie et al 2013 p22, Patton 2015, Robson 1991).

In accordance with the criteria of Williamson et al. (2011), actioned research:

- Is Educative;
- Deals with individuals as members of social groups;
- Involves a change intervention;
- Aims at improvement and involvement;
- Involves a cyclical process in which research, action and evaluation are interlinked;
- Is founded on a research relationship in which those involved are participants in the change process.

The case study method is difficult to define (Patton 2015). Looking at what this research is not concerned with provides the clarification to see how the case study method sits within this project. The question this research addressed was how can one use communication technologies to deliver public health agendas in National Health Service food and drink automated vending? In interpreting the question, this project was not concerned with comparisons between cases, and so cannot be described as a case study piece of research (Gerring McDermott 2007). Given the research context, the work took place in one location giving within case variability and allowing one to see differences in specialist areas on one site. It would however be possible to replicate this study across multiple sites in the future with a small team rather than a single researcher.

The research also did not conduct the experiment at multiple time intervals as the duration of the project was not long enough. Had the project been longer, one could conduct the experiment as a case study by repeating it multiple times and comparing each set of results.

A case study approach could have been taken to formally evaluate if the findings of the primary research were embedded in the organisation to ensure effective delivery of policy. The research question would have had to ask what impact had been made by the policy changes over time, for example. Case study method may have been used to launch future comparisons between NHS Trusts using this project as a pilot study to formulate a framework of analysis and the basis of a larger scale project. This could be a future approach, extending the scope and impact of the project.

Quantitative, qualitative and mixed methods

The binary positions of research method design are either qualitative open-ended or quantitative closed ended (Creswell 2013). Quantitative methods are common to traditional FM research, resulting in easy to measure, department specific outcomes (Campbell 2017). Collection and analysis of the stock records in the point of sale experiment and the large-scale survey of staff as key end service users are both quantitative pieces of primary research work. The worldview underpinning these activities is positivism because it allows for statistical validation of results and material measures and quantities attributed to sensory experiences (Ritchie et al 2013 p.8).

In comparison to quantitative research methods, qualitative methods interpret and foster in-depth understanding and representation of the social world. They draw on adaptable methods and emergent issues, resulting in data that is detailed and rich with cross-cutting themes from complex and unique participant perspectives and emergent categories and theories. It also is a reflexive approach which acknowledges the role of researcher (Ritchie et al 2013 p22). Qualitative methods are also essential to understand the impact and overall success of changes made (Schedler 2004, Rose and Cray 2010). The informal research in this project was well-suited to qualitative methods.

If the research were to develop the qualitative work done further, mixed methods can combine qualitative and quantitative methods and offers flexibility and a breadth of research design options and array of tools, once specific research questions have been formulated (Howe, 1988, Tashakkori and Teddlie 2010). Mixed methods research is associated with a bottom-up, realist, pragmatic and/or grounded approach to connecting abstract epistemologies to mechanical levels of actual methods (Ritchie et al. 2014 p.39-47, Tashakori and Teddlie 2010, Cameron 2011, Morgan 2007). This approach is part of a wider debate across many different subject areas, institutions, governing bodies and funding partners about the divides between academic disciplines and how they might be brought closer together (Nenonen and Sarasoja 2014, Davies 2011, Moran 2002, Strijbos 2010, Fredericks 2010, The Bartlett 2014 Wagner et. al. 2011, Klein 2004, Klein 2006, Falk-Krzesinski et. al. 2011, Hadron et. al. 2010, Huutoniemi et. al. 2010, Nenonen, Truffer et. al. 2008, NRC 2004, Culligan and Pena-Mora 2010).

The literature on mixed methods and other related fields, such as actioned research, emphasises the topology of research methods; the weighting, looping, cyclical, linear or nested order in which events are introduced and continue through a project (Hall and Howard 2008, Hall et al 2008, Williamson et al. 2011). Describing the topology of primary and non-primary, quantitative, informal and/or qualitative research methods that one might use to produce new knowledge creates a narrative to the investigatory path being taken (Tashakori and Teddlie 2010).

This research took opportunities for informal research continuously wherever possible and, at the same time, produced the quantitative research linearly, from scoping to implementation and analysis.

Sampling strategy and generalisability

If an order had to be given to this research, it could be said that it uses a multiple case sampling method, prioritising informal research case information with quantitative experiments and data collection to back up, test and prove the approaches taken, and to elaborate on critical aspects of service delivery from within (Tashakori and Teddlie 2010). In this instance the informal data collection would be described in stages, each stage a distinctive case. Each quantitative collection and analysis also a distinct case, and these defined areas of work placed linearly to show the decision making path more clearly and formally. The sampling strategy would,

therefore, split into two and be applied across the different cases. Samples either represent the end service user or the governance and service provider groups. End service users quantitatively analysed and the latter analysed using qualitative methods, layering design decisions by researching across both samples, reflecting on design proposals, adjusting and retesting solutions. Within the two samples, broadly internal and external groups, there are a number of different potential studies with unique sample populations and bringing them together into a unified research framework, beyond descriptive qualitative work, would require a larger project scope than this project alone.

The strategies chosen for each piece of primary research captured in-depth knowledge that can be used to inform the aims of the research across the entire service, as well as the development of interventions that can be used and simulated by other vending service providers across NHS Trusts.

Reflection on the ethics

Ethics approval was sought out and granted from the ethics approach committee at University College London. The approval letter can be found in Appendix C. The ethical consideration of the point of sale experiment was that it applied subtle methods to influence people's choice of food. This could, in turn, influence their health. Using the proven Rayner (2005) nutritional profiling method of choosing which products to promote and encouraging people to buy the healthiest items ensures that ethical issues are addressed. Futhermore, the experiment does not in any way promote the use of the vending machines. Rather, it is only once someone has decided to use the machines that they are encouraged to choose the healthiest possible item. Regarding the survey of staff for catering services, names were removed to preserve anonymity. Full permission was received from the Trust and contractors for the data gathered.

4.2 Point of sale experiment overview

There has been explicit call for more understanding of how to influence user choices in vending interventions, as well as a call for more understanding of how to influence vending choices in healthcare settings specifically (Skov et al 2013, Hua and Ickovics 2016). This experiment tested Nudge or choice architecture-style interventions for the improvement of vending services within Barts Health. The premise was to influence product choice by redesigning the point of sale environment using a range of technologies (Thaler and Sunstein 2008, Skov et al 2013, Terlutter and Capella 2013, Darby 2006).

Thaler and Sunstein (2008) highlight a number of barriers that can impact people's choices, such as a lack of free cognitive capacity, information, self-control or attention. These are particularly significant in vending in healthcare. Often machines are situated in busy, loud environments where people may be distracted, stressed, emotional, unpredictable, working long hours or waiting for long periods of time. Full information is also likely to be missing as the product as behind a glass screen. Nutritional information on the back of packet, for example, cannot be accessed. Finally, the design of vending machines is such that they are intuitive to use and automated, making people more likely to pay less attention while making choices.

One of the central technologies used in the design of interventions was a nutritional profile, allowing products to be ranked most to least healthy, and split into either red, amber or green labelling categories. This has been trialled in catering settings before, but not for vending and not in healthcare (Skov et al 2013, Hua and Ickovics 2016). The literature review of the thesis gave in-depth consideration of the appropriate nutritional profile to use, opting for the Rayner (2005) across-the-board profile. This is the first time the profile has been formally applied to vending, making it a novel contribution to knowledge. The experimental period of the point of

sale experiment spanned 36 weeks out of the 54 weeks where data were collected. Product stock level data was used as the measure for testing interventions. The interventions that were tested were product replacement, traffic light labels, and product placement of water in the vending machines. The overall impact on revenue was also included to show if the interventions had a negative impact on sales. Finally, different locations were considered. For example, staff only, busy or quiet areas. The experiment used multilevel statistical analysis to achieve this.

Point of Sale Hypotheses

The main hypothesis in this experiment was that planned communication-based interventions using different technologies to change the point of sale vending machine environment can influence users to make healthier choices.

In this experiment, the feedback that consumers got about nutritional content occurred prior to their purchasing choice, equipping them with the knowledge that they need to make the best decision.

The main measures that required testing, chosen in collaboration with Barts Health and with reference to the literature, were:

- Nutritional value of products;
- Product placement, location of food in vending machines;
- Substituting for healthier options.

The null hypotheses for the point of sale interventions were:

- Any intervention would have no impact on red product sales, red drink or red food sales.
- Adding nutritional traffic light labels would have no impact on red product sales, red drink or red food sales.
- Adding a change to make water closer to eye level in the vending machine would have no impact on red product sales, red drink or red food sales.
- Adding a new product range would have no impact on red product sales, red drink or red food sales.

The outcome measures could be analysed in terms of whether the space was busy, if it was a clinical space, or if it was a staff space. This would allow service to be designed in targeted ways. For example, if the null hypothesis for label interventions was only disproved in busy locations, then with limited resource available, labelling efforts could target busy hospital areas to maximise resource. If an intervention worked universally, then it might be written in to policy or contract communication, or carried forwards for wider testing.

There were other sub-hypotheses that were considered but not tested in this experiment. Firstly, if the ethical qualities of food including fair trade and food miles impacted choice. And secondly, whether cost would influence. These were not feasible as ethical information labelling would conflict with nutritional labelling and price would have too big an impact on revenue for contractors to agree to.

The individual intervention designs, and their development and accompanying literature, will be discussed in further detail later on in this chapter. First, there is a discussion of the overall research design and the population and sample.

Research design and major research activities for point of sale interventions

The work intervened at point of sale. This required a top-down, deductive research approach (Ritchie et al. 2013 p8). The design of this research activity was informed by the wider inductive research work done, much of which was discussed in the literature review given that it was not formalised in the primary research portion of the research project and was largely exploratory, partially following research traditions of grounded theory.

Major research activities:

- Establish interventions design based on feedback with key service stakeholders and literature;
- Design experiment structure spanning 54 weeks and 30 locations within Barts Health hospitals;
- Carry out and monitor experiment, working directly with vending stockists on site;
- Analyse data using linear regression modelling to allow inclusion of several locational factors;
- Reflect on capacity of the innovations to reduce the least healthy vending.

Population

The target population was staff, especially night shift staff, given that the reason vending is installed is to provide meals during out of hours' periods to staff. In reality far more people use vending that it was originally contracted to serve. The population were made up of vending machine users at St Bartholomew's and the Royal London University Hospital (RLH), anyone making a purchase in the period of the year that data was collected. It was thought that vending machines at Barts Health would be for staff only given that they are contractually meant to be there to provide catering to out-of-hours staff. Staff are, however, not the only users of vending machines, and machines have been placed across the entire Trust, including in areas that are mainly occupied by patients and visitors, such as family waiting rooms. Therefore, the results of the experiment were applicable to more than just staff. The analysis did however divide analysis between machines in staff only vs publicly accessible locations. Incorporating unexpected population was an opportunity for the research to impact a wider more diverse population.

The population using vending machines varies between different locations. For example, in paediatrics there will be more children in the population and in staff rooms there will no members of the public. Furthermore, in renal there will be more repeat visitors with specialist restricted diets and in A&E there will be more one-time visitors. In different areas, the profile of users will also change. For instance, stress levels may be higher in areas such as A&E. And finally, there will be less user traffic at machines in remote locations within the building.

The experimental interventions were installed at the busiest Barts Health site, the RLH. Observations, revealed that there are 40 vending machines selling predominantly high fat, high sugar, high salt or artificially sweetened products across the various locations in the hospital. 30 vending machines in the main building had interventions placed within them.

The RLH has a growing constituency of people, including those communities who work there, receive treatment and visit the hospital sites, with the lowest life expectancy and highest incidence of long-term preventable health problems such as obesity, in the UK. This places Barts Health and its staff under considerable pressure, not only in the care being provided, but also to create a culture of healthy eating that inherently promotes long-term health at the same time.

By making healthy choice the norm in vending services, Barts Health is creating a culture that promotes long-term health for the local communities who work, receive treatment and visit the

hospital sites and setting an example of how to live a healthier life. The project particularly targets staff as a majority of the machines are located in the non-clinical spaces and staff only areas.

Regarding the vending machines themselves, and specific locations in the RLH, a number of population and sample features were revealed in informal discussions and observations that further define the population being studied. Discussion with the security manager at Barts Health, with access to the security access cardholder records for the RLH, confirmed that 14,000 members of staff have security access the RLH and Barts Health in total. There are approximately 8,000 members of staff at the RLH.

Sampling

Stock levels were recorded from 30 vending machines across 28 locations (busy locations had separate machines for food and drink) within the main building the Royal London and St Bartholomew's hospitals. As all machines were included from one site, vending machine sampling was not random. The sampling scheme of the hospital population of people using those machines was random in the sense that anyone on the site was able to use the machines at any time during the experiment. While it was important from a policy perspective to look at staff using machines, there was also opportunity to understand the wider population use. Although it is not a direct focus of policy it remains a public health concern for the dieticians that this researcher consulted in Bats Health and so the decision was made to include the broader population.

The hospital site serves approximately 1 million outpatients per year, plus inpatients, visitors and staff. The sampling scheme was therefore of a large sample size. Vending machines were located across the main building of the hospital. Some machines have distinct populations, such as staff, non-staff, and clinical or non-clinical staff. The large population size increased the power of this research, and reduces the standard error, which ultimately increases the supposed validity of the findings.

4.3 Scoping point of sale interventions

This section includes detailed description of the procedures starting with the development of each intervention design and then discussing the overall procedures.

Decisions made in the literature review chapter

The literature review determined that labelling products was going to be a key aspect to the primary research. Government policy guidance advises, among other initiatives, that at point of sale, clear information and labelling and use of traffic light food labels in vending machine services might aid service improvement (HFSP 2014, NHS England 2014, WHO 2015, DoH 2014, Marmot 2010). it is yet to be seen how these latter theories inform vending machine design, given that the focus in policy is on nutrient labelling and choice architecture (Skov et al 2013, Hua and Ickovics 2016). It was also decided in chapter two that across the board nutritional profiling would be the best way to create nutritional labels.

It was decided that the user environment was a key way to influence user choices. The decision to use busy and quiet areas as a conditional variable in the point of sale experiment was also something derived from space syntax theory. Space Syntax describes how people move within the built environment, as a performer among many, sharing a collective pattern of behaviour, and the social significance of space, given its structural properties (Fata gen. Schiek et al 2009,

Fata gen. Schiek et al 2008, Schnädelbach et al 2007, Schnädelbach et al 2006, Hillier and Hanson 1989, McCarthy and Write 2004). These ideas were used to differentiate the spaces in the experiment. For example, most and least busy areas, either with a high or fast flow of people, or slow moving areas such as waiting rooms, were differentiated in the analysis.

The decision to test if moving products to eye level encouraged product purchase was derived from the research discussed in 'Further ideas for developing measures of public health in vending', to do with tracking visual gaze using biometric data.

Developing the traffic light labelling

The first step in creating a meaningful way to summarise and communicate a nutritional profile to end service users was to find out what the nutritional properties of the products were. A list of all the products in vending machines at the research sites was gathered by accessing the vending contractor's records and doing checks on the machines in the hospitals. A database was created in a spreadsheet.

Filling in the nutritional properties of each product revealed that different sources reported nutrition differently. Nutritional values were sourced online, as it was not possible to open up vending machines and check the products individually. Nutritional values were ideally sourced from the product company web pages. If not, then from the webpages of supermarkets Waitrose, Tesco and Sainsbury's. This lack of information negatively impacted the robustness of the profile however it was felt that all reasonable steps were taken to mitigate the inaccuracies and omissions found from nutritional records.

It was found that nutrients on these different sites were sometimes rounded up or down per portion size and, when the value was scaled up to represent 100g/ml, the difference in reported nutrients was exacerbated. Errors in nutrient reporting were also found comparing the different supermarket websites in different cases. The database collection also revealed that portion size of product was recorded differently by one or two grams on different websites in some cases, and portion size was difficult to find or, in some instances, absent. There was a lack uniformity overall in the nutritional values being presented online. There was also less information available from smaller manufacturers and some did not provide any information at all. New companies selling more ethical or healthier foods might be placed at a disadvantage due to their poor nutritional reporting as a result. Where discrepancies occurred, they were highlighted on the spreadsheet.

To calculate salt and sodium the following calculation was used, sourced from the NHS 2014 'live well' site.

Salt = sodium x 2.5

This is, however, not the only way to calculate salt. This approach was chosen as it represents the government's policy position on salt calculation. The research tried to use the policy as its' guide in design given that the aims were about policy delivery. Fibre is also reported in different ways. Some of the larger companies were contacted during this research to ask which they used. Mars replied that they use Association of Official Analytical Chemists (AOAC) fibre so an assumption was made that this was the kind used by all. It cannot be said for certain that all companies reported in this way and it was not possible to check.

First iteration of the nutrient profile design

Barts Health nutrition in action team (NAT), working groups, the head of dietetics and catering managers at the Trust, as well as the public health directorate team, were all consulted in developing the nutritional profile. In initial feedback from dieticians in Barts Health at NAT meetings, the FSA guidelines were considered by the dieticians as the ideal way to communicate information about health to vending machine users, as the standards were recognisable and well-sanctioned. The dieticians requested that the sign could be displayed beside vending machines (although theoretically any retail outlet) to advise people on their purchase. This was not possible, however, as customers cannot see the back of packets when purchasing products, and so could not read what nutrients are in each products. Therefore, a sticker such as the one shown in Figure 17 could not be used.

The products were profiled according to the guide. A list was produced of products, showing what colour each nutrient would be according to the guide and might help further discussion and ideas for a different system. A sample of the results shown is shown here:

Code	Description (measured in grams, per 100g	Size	Sug	Fat	Sat fat	Salt
1062	Wispa	39	52.5	34	21	0.23
1026	Minstrels	42	69	22	13	0
1002	Aero Bubble Peppermint	40	61.8	29.7	18.2	0.28
1130	Dairy Milk Fruit and Nut	49	54	27.5	15	0.2
2001	Quavers	20	4.1	30.1	2.7	0.87
2002D	Just Crisps Salt, Apple and Balsamic	40	1.25	32.5	3	0.5
2210	Golden Wonder Rough Bang Bang Spicy Thai	50	3.1	28	2	1.5
2213	Marmite Crisps	34.5	3.4	30.7	3.1	1.52
2209	Golden Wonder Rough Cheese and Onion	50	6	27	2	1.5
2207	Golden Wonder Rough Salt and Vinegar	50	4.7	27.7	2	1.5
1014A	Nature Valley Bar Oats and Honey	42	28.6	34	1.1904	0.4
1002E	9 Bar Pumpkin	50	23.5	34.6	6.6	0.16

Figure 17 First iteration of nutritional profile

While this was useful as a tool for discussions with dieticians and contractors about potential alternative options for products, it was not easy to translate onto the vending machines as a display. The full product details could not be displayed on the machines because there was limited space and it was felt that people were often visiting for convenience and not at the machines for long enough to read such detailed information. Another limitation of the profile is that the range of nutrients is limited. It does not record potentially positive nutrients such as unsaturated fats, vitamins, fruits and fibre.

Finalising the profile

In line with the development of the FSA Ofcom model, 'foods and drinks should have separate thresholds for defining 'less healthy' foods' (Rayner et al. 2005). Traffic light colours were chosen in this study to indicate how healthy an item was as they are an intuitive method of indicating the range of choices available to users in a way that immediately highlights the 'best' choice in green. Choice architecture studies have supported this, finding in one study that traffic light colours can influence decisions towards reducing red labelled foods in canteen settings in healthcare (Thaler and Sunstein 2008). The idea of creating a 'worst choice is based on nutritional value of each product in this case.

The range of available items that were available across the whole vending service were scored according to the profile and placed into order from smallest to largest scores, then split into three even groups based on frequency. For drinks, anything scoring zero or less was green, one was amber and two or above was red. Food items with a point falling into the lowest third of possible scores were attributed green, then amber, then red for those items within the top third of available points. Once the profile has been applied to the product range, a small red amber or green dot could be affixed below each product. The image in Figure 18 shows there is a round space where the stickers fit.

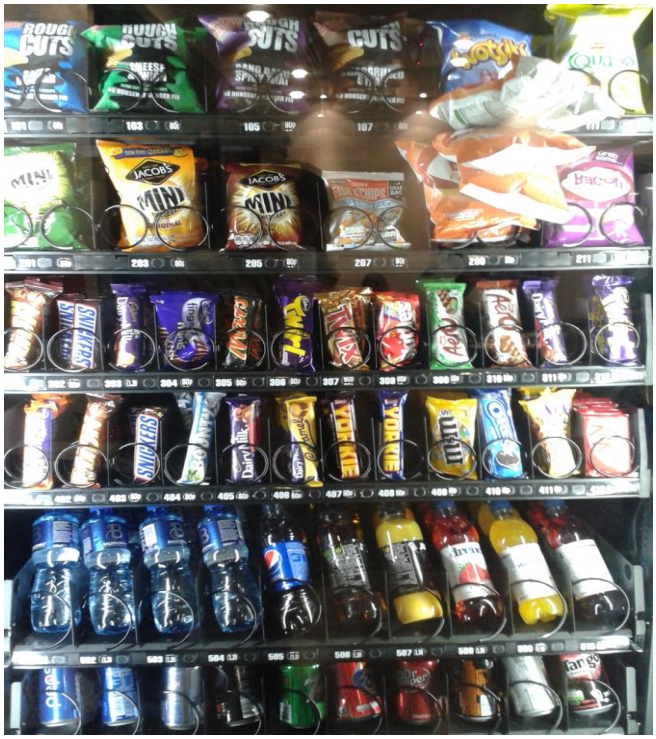


Figure 18 Vending machine image

This was discussed with the public health department and the estates management and communication teams to get feedback about how to display information before proceeding. It was agreed that a poster detailing the researcher's contact details along with the product score and a brief description of the experiment should be placed as close to the machines as possible.

Design of supporting communication

When the NAT group were consulted about the case study they gave the feedback that traffic light colours could potentially be misleading, suggesting that a green item is healthy and indicating 'go' to the user, rather than highlighting the healthiest options available. To address this concern, an A6 poster was placed on the machine with 'least healthy', 'mid-range healthy', 'most healthy' written beside corresponding red, amber and green circled stickers (Figure 19):

Figure 19 Intervention poster 1

Another more detailed poster (Figure 20) was placed in the nearest space beside the machine explaining the trial, giving a list of products and their nutritional rating, and contact details for anyone wishing to discuss the trial.

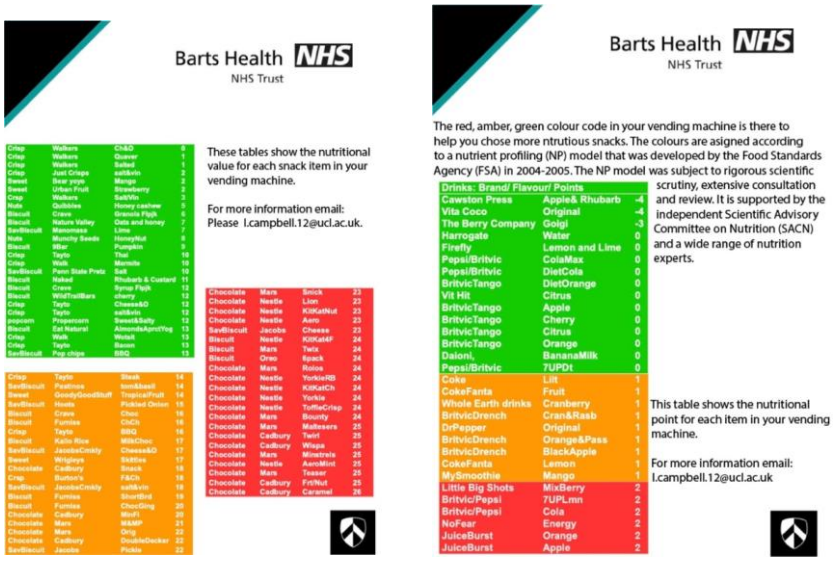


Figure 20 Intervention experiment poster 2

The poster in Figure 20 reads:

The red, amber green colour code in your vending machine is there to help you choose more nutritious snacks. The colours are assigned according to a nutrient profiling (NP) that was developed by the Food Standards Agency in 2004-2005. The NP model was subject to rigorous scientific scrutiny, extensive consultation by the Independent Scientific Advisory Committee on Nutrition (SACN) and a wide range of nutrition experts.

Both posters also read:

This table shows the nutritional point for each item in your vending machine. For more information please email l.campbell.12@ucl.ac.uk. Emails were received from several members of staff complaining about the machines being unhealthy for their patients and also to ask that

vending machines be installed in their wards. This will be considered in the results section of the thesis.

The posters were compliant with the Trust's communication team poster format as much as possible, based on the template provided by the communication department. Posters were placed as close as possible to the machines and, where possible, on the vending machine itself a more detailed poster was put up, explaining the experimental design in more detail.

Designing product placement to make healthy products easier to see than others

The interventions drew on the intuitive understanding that placing products at eye level will encourage people to choose them. This has been trialled and proven successful in similar scenarios (Thaler and Sunsain 2008). Nestle produce the following guidance for vending Figure 21:

Figure 21 Vending display hotspots (Anonymous)

This was provided in unpublished third party correspondence between Nestle and the vending contractor Vending Solutions, sent by company director via email to the primary researcher at l.campbell.12@ucl.ac.uk 02/12/15. It was later verified by this research in a phone call to Nestle, and affirmed that the same systems are used by Mars and Cadbury. Essentially it represents the widely accepted idea that products at or closer to the centre of the users field of vision are more likely to be sold.

Water was chosen as the drink product to move as it is truly the healthiest drink option. The green snacks were already at eye level in the machines so these were not tested.

Changing products for healthier option

It may seem intuitive that one might remove unhealthy options completely from the vending machines and only sell green products. However, this was not an option due to contractual restrictions, and policy does not advise that this approach should be taken. In reality, the 'healthy' product range option was assigned by the vending contractor, under their sister company for healthy vending called Rude Food. The Rude Food range contained a higher proportion of green products but not entirely green products.

colour	rude food	traditional
red	13	56
amber	18	31
green	119	62

Figure 22 Rude food product colour codes

The table in Figure 22 shows that the majority of rude food products were green.

4.4 Procedure for point for sale experiment

Of the 30 machines, all contained this labelling intervention, 13 machines also had product placement interventions, moving water either completely to eye level or as close as possible. Four of the machines had machines had product replacement, using the vending machine company's standard healthier range, to replace the traditional one. These four machines also included water placement.

12 weeks of baseline data was collected, then 12 weeks of trial data for labelling interventions, 42 weeks of water interventions and 42 weeks of product placement intervention, and 30 weeks of post labelling interventions. This meant that interventions happened at different times in different machines for different durations of time. This variation was largely to accommodate for service demand and capacity for change among the service provider. The interventions were installed by the researcher, who worked alongside the vending stockist to install the interventions. The stockist then maintained the interventions until the end of the 12-week trial period when the researcher uninstalled the trial.

The company who control stock records and deliver vending services at the study site were Vending Solutions, and their sister company, The Rude Food Company. They were contracted by Carillion, who manage soft FM services at Barts Health. Gaining permission required building good working relationships with the company, as well as managerial support across companies and departments, supported by the environmental manager at Barts Health and Public Health director.

Vending machines were restocked and cashed up frequently, with the busiest locations are serviced every day. The 'healthy' Rude Food versus 'traditional' Vending Solutions products are stocked by two different people. Stock is stored in a cupboard in the basement of the RLH and brought up in trolleys. When the machines are restocked, the stockist uses an electronic hand held device with software installed to record the location, time, product description, product code and quantity electronically. The information is sent to a central database called Opera. Any faults are also reported via this system. Notes about machine movement, profits and historical data are stored in this database.

Working with the primary stockist on site made it easier to liaise over practical measures of the trial, such as changing stock around. The company director was enthusiastic to help with the experiment.

Vending Solutions explained that the products typically sold in the vending machines are chosen for their long shelf life, popularity and high profit margins. They reported that healthier, more ethical products are often more expensive to buy, less popular, and have shorter shelf lives.

4.5 Method of analysis for point of sale data

The step prior to analysis was to establish permissions and access to data. To establish what food choices were being made by stakeholders at point of sale. The contractor Carillion initially provided three months of data, including the number of each items sold in each machine. This information would have been insufficient to achieve the in-depth understanding that was required to answer the sponsor questions, and at the same time conduct a study lasting long enough to generate valid and useful results within research communities.

Direct access was required to the subcontractor records. Vending Solutions records were not accessible to Carillion or Barts Health. These records held the fine grain reports on week-by-week sales including more detail about machine numbers and locations, faults and exact sales records. With information about which vending machines were in which location, a set of summary reports could then be pulled and copied into a single spreadsheet for each location, separated into before, during and after time periods.

At this point in the research project, the time that this researcher had spent embedding herself, and forming face-to-face relationships was a critical enabler. The trust between herself and the subcontractor Vending Solutions meant that the organisation allowed her to use their systems directly. Data was collected by the researcher directly from the vending company's stock records. This meant taking several trips to the head offices in Southampton, and eventually being given remote access to work from the London research offices. This reinforces the significance and success of the research approach taken in this project, to embed and scope the project, and to make it highly applied and part of a larger, holistic approach to service improvement. It is felt that the access to sales records would not have been possible without the chosen approach.

Data collection, cleaning and ordering

Data cleaning and ordering during the collection stage of the experiment was performed using Microsoft Excel. When the vending machine stockist tops up products in the machines, they record the amount of each product stocked using a mobile phone. This information is automatically stored in a software system called Vendman. This holds records of all Vending Solutions clients including Barts Health and many other hospitals, healthcare centres and other companies. The Barts Health account included locations across The Royal London and St Bartholomews. The system also recorded whether products were part of the traditional Vending Solutions range, or the Rude Food Co. range being promoted as healthier.

A software application called Crystal Viewer could then be used to extract summary reports from the central database of stock records. Crystal Viewer can only create certain reports, and so it was only possible to create week-by-week reports for each machine, which then had to be collated into a central database.

The reports pulled were formatted as shown in Figure 23:

Visit Dates from 02/06/2015 to 09/06/2015		
Stock Ref	Qty	
1001	3	AERO MILK
1002	3	AERO BUBBLY BAR PEPPERMINT

Figure 23 Vending sales report example

Every product has an individual 'stock ref' or stock reference which changes for each product. This example refers to machine 767 (which one could check on the records and find was located in the renal waiting room) and the date range can be seen on top so that one could add up the time periods correctly.

Data cleaning

The task of taking week-by-week reports for each machine was a laborious but important process in order to check for inconsistencies and fault reports for each machine. Other information, such as the location of the machine, any faults and the account details, could also be checked.

Some of the machines were intermittently inactive, due to a technical fault or a period of time when the product range was being swapped from traditional to the Rude Food product range. Machine locations also changed for the same reasons. Machine locations were searched manually and recorded separately based on operator notes on the Vendman system. This process of searching was also verified by monthly spot checks throughout the experiment period, when visits were paid to the hospital spaces to walk round and check the machines.

Where this search revealed that the machine was inactive, or there was no machine in place, weeks were deleted from the data set. More discussion will follow on how this was dealt with using the choice of statistical tests.

A spreadsheet was kept, indicating what machines were in each location and active for how long. The baseline used was 12 weeks of prior records about what products were sold in which machines and how many of each. Figure 24 shows an example:

	Baseline		Trial		Post-Trial	
	Weeks	Machine code	Weeks	Machine code	Weeks	Machine code
Bridge Outside Restaurant Royal London Hospital Level 5	11	725	12	725	12	725

Figure 24 Machine list with times and location

The data set was also checked for mistakes. For example, where the incorrect date ranges were entered when pulling summary reports. If product sales were more than five times higher than the average for that machine, they were discounted and replaced with an average. It was not possible to go back to the Vendman system, as the contract with Vending Solutions ended shortly after the experiment, given that the catering contract and soft FM contract ended.

Summarising the data

Once the data was collected into a central spreadsheet, the outcome measures were further summarised by their attributed colour, either red, amber or green for drinks and food. The data was then swapped from wide to long format. Other variables were also added to the database such as the location of the machine: if that location was busy, if it was clinical and if it was a staff area. Machines were summarised by location. Most often a location contained one machine selling food and drink. The busiest locations contained two separate dedicated drink and snack machines. In these cases, product sales from locations with two machines were added together during the data cleaning and ordering phase.

The table in Figure 25 shows all the exposure, conditional and outcome variables in the original data set once it had been cleaned and summarised.

exposures	conditionals	Outcomes given in %
Any intervention	Clinical space	Red product sold
Intervention labels	Location busy	Red drink sold
Interventions water	Staff space	Red food sold
Intervention product range		

Figure 25 Point of sale variables list

The table in figure 25 shows what exposures were being tested, how the results would be grouped according to the conditionals, and the outcome measure being used to show the results of the experiment.

Clinical spaces were described in terms of the space usage. For example, waiting rooms for clinical areas were deemed clinical whereas canteens, staff rooms, and discharge lounges were not. Staff spaces were deemed as those with security access installed specifically to separate staff from the public, meaning that the public could not access those areas. This included staff rooms and offices.

The variable of location busyness was quantified using measures of quartiles (Figure 26).

Summary statistic for location busyness variable by quartiles	Sales
Max	35328
Average	6070
First quartile	2367
Second quartile	5687
Third quartile	7094
The threshold for busy was set just above the second quartile.	

Figure 26 Calculating if a location was busy by quartiles

The location busyness variable was included based on Space Syntax theory; that people might behave differently in busier spaces (Fata gen. Schiek et al 2009, Fata gen. Schiek et al 2008, Schnädelbach et al 2007, Schnädelbach et al 2006, Hillier and Hanson 1989, McCarthy and Write 2004).

The variables were listed on the top row of the database. The columns of those that required yes or no information were coded using a nominal scale of 0 or 1. 0 represented no, 1 represented yes. For example, a 1 under the variable staff space would mean that that row of data was about a staff only space in the hospital.

A few other summations were made. Time was placed into an ordinal scale of before, during and after the interventions were installed. Each of the three time periods is a discrete classification of the data. Finally, the data were reported as percent frequencies. For example, in the before intervention time period in location 1, x% of red products, y% of amber products, and z% of green products were sold, making a total of 100%.

4.6 Inferential and descriptive statistics for point of sale intervention

The tool used for analysis was Stata. This was chosen as supervision of statistical methods was provided in Stata. It used a retroductive logic governed analysis. Retroductive logic is about 'Identifying the structures or mechanisms that may have produced patterns in the data, trying different models for 'fit'' (Ritchie et al. 2014 p6). This models of 'fit' approach, was used to determine the relationship between different exposures and conditions, and the outcome variables. The actors included location purpose, population features, intervention type. The exposures were tested first individually in univariate analysis. The mixture of exposure and conditionals was then tested in a multivariate analysis.

This approach allowed insight into the reason behind solutions. To deliver healthier products and increase demand for them might be made more or less possible depending on the intervention, and the characteristics of the location. This retroductive approach was ideal as it might lead to optimal point of sale design where little was known in the context of healthcare vending prior (Ritchie et al. 2013 p6, Skov et al 2013, Hua and Ickovics 2016).

Descriptive statistics

A number of preliminary calculations would be performed on the data once they had been ordered and tabulated in summary form. These included the number of weeks of data in each category of conditional variables. For example, the number of weeks of data describing clinical compared to non-clinical spaces.

Inferential statistics using univariate analysis for point for sale data

The subject in the statistical analysis was the change of product choices over time. The statistical methods to measure this were split into univariate and multivariate analysis. The first tests to design were for univariate analysis. The choice of an ordinal scale of time, grouping results into before, during and after periods, made it possible to give one measure per period. This measure was the mean of the % frequency for each outcome measure. For example, before the intervention, x% of products sold were red.

Each measure was regarding the same subject and so was paired. Pairs were calculated as before and during, during and after, and before and after. However, these paired tests would have to be performed for several outcome measures. The typical test for a before, during and after style-intervention study of paired data would be a paired t-test or a Wilcoxon test, depending on whether the data were normally distributed.

To check the normality of distribution for each outcome measure in the before, during and after categories, a Shapiro–Wilk test for normality was used. The Shapiro-Wilk test (typically called

"W ") is used is a test for the normal distribution of a random variable (Lewis-Beck et al 2003). The equation is:

The Shapiro-Wilk test (W test) equation

$$W = \frac{(\Sigma_{i=1}^{N}\ a_i X_i\ )^2}{\Sigma_{i=1}^{N}\ (X_i - \bar{X})^2}$$

The test would reveal, for example, if the % of all red products sold before the interventions were evenly distributed in a bell curve. The test would check using the % of all red products, % of red food, and % of red drinks. For each of the three groups it would further check (Figure 27):

	Any interventions	Label intervention	Product range intervention	Water intervention
Before	yes	yes	yes	yes
During	yes	yes	yes	yes
After	yes	yes	No after period	

Figure 27 table of variables describing the data on which normality tests were performed

A total of 30 tests for normality were conducted. For all three outcome measures of % all red products, % red food and % red drink, there was no after period for interventions of water or product range. This is because once the interventions of water and product range were installed they remained until the end of the trial period and beyond, and so there was no after period to measure or test. Therefore, 30 tests were carried out in total to check for normality of distribution and decide which statistical tests would be appropriate.

The null hypothesis was that the data was normally distributed. If this was the case, given that the data for either before and during, during and after, or before and after had a linear relationship and were paired, a paired t-test would be performed. This would allow one to compare before to during, during to after, and before to after time periods of the experiment. This would also mean reporting the mean, the P-value and the 95% confidence interval in the results.

If the data were found to be non-normally distributed, further consideration would have to be given, and perhaps more tests run, given that even a paired t-test can still be robust even when the normality assumption does not hold (Rabe-Hesketh and Andres 2001). If the paired t-test and sign test P-values were very different then a sign test would be used given that a sign test is more robust against non-normality[1].

Having run the Shapiro–Wilk W test, if the results gave a P-value under 0.05, this meant that the null hypothesis could be rejected, and one could be sure that finding non-normally distributed data was only due to chance ≤5% of the time. In this case, given that the data would be found to be non-normally distributed, a sign test or as it is also known, a Wilcoxon signed-rank test would be performed instead of a paired t-test, reporting the median and the P-value only and

[1] 'The P-value for a statistical test of a hypothesis is defined as the probability, calculated under assumption that the null hypothesis is true, of obtaining a sample result as extreme as, or more extreme than, that observed in a particular direction' (Lewis-Beck et al 2003). This research uses the most popularly accept threshold for the P-value. To say that the P-value is ≤0.05, it means there is a ≤5% probability that the finding was due to chance (Lewis-Beck et al 2003).

not the 95% confidence interval. This sign test is weaker than the t-test, however, it is the alternative in instances of non-normal distribution of data. The sign test provides a comparison of the probabilities of two types of outcomes and can be used to make inferences about the mean of a population of differences (see Lewis-Beck et al 2003 for a full explanation of the procedure). The P-value reveals whether a finding represents the probability of the median value having happened by chance in this case.

Inferential statistics using mixed-effects for point of sale data

The second set of tests carried out were for a mixed-effects multilevel regression. In comparison to mixed-effects, using independent pairwise comparisons would mean multiple exposures and outcomes had to be given, performing pairwise comparisons many times. This would also increase the error rate. Therefore, pairwise comparisons were only useful for univariate analysis. Using repeated measures allowed for a dependent structure to be created, and was more sensitive to detecting difference between groups than if one were only to use a single point (as was the case in the univariate analysis). Favourably, repeated measures also allow one to answer questions about the entire profile over time.

Mixed-effects is useful for categorical and continuous outcome measures, for multiple exposures and conditionals that can also be a mix of categorical or continuous. In this case, the measure was continuous and the outcomes were categorical. Mixed-effects also accounts for the fact that outcome measures are grouped within subjects, can be used on complex data and also where data is missing.

There are two types of potential analysis for repeated measures, anova and regression. Anova, was discounted as it does not allow for missing data. For example, if a week of stock records were missing from a certain vending machine location, that location would be unusable via anova methods.

In total, the two models used were:

$$Y = a + D * \textit{time period} + E * \textit{staff space} + F * \textit{busy space} + G * \textit{clinical space}$$

$$Y = a + C * \textit{intervention labels} + H * \textit{intervention product range} + C * \textit{intervention water placement} + E * \textit{staff space} + F * \textit{busy space} + G * \textit{clinical space}$$

The second equation was run in order to compare before to during, during to after, and before to after.

The sums used for mixed-effects were as follows, given that regression assumes:

$$Y = a$$

In regression, a is the intercept and Y is the outcome.

For linear regression, a binary outcome (2 levels counting) includes:

$$+ C * \textit{intervention labels}$$

Intervention might be zero or one. C is the mean difference in Y between no labelling intervention and with labelling intervention. For example, mean red stock in machines where labels were not added minus mean red stock in intervention machines where labels were added.

In linear regression, a categorical (≥3 levels) includes:

$$+ D * \ time\ period$$

Time period might be before, during or after the interventions in this example, represented as zero, one or two, so there will be three values for D. Each one is the mean difference in Y between the reference group (which was chosen before) and each of the other categories.

For the categorical variable of time period, the control was counted as the baseline period before the interventions were installed. And the active periods were when interventions were installed. This analysis also included post-interventions in the analysis, and so in another model, where only binary variables were used such as intervention and no intervention, before was compared to during, during to after, and before to after. The subject in the multivariate analysis was the change of red product choices, given in separate models for the different time period comparisons, and also for all products, and food and drink products.

There was a further set of binary variables representing the conditions of the vending machine location. For example:

$$+ E * \ staff\ space$$

Staff space could be zero representing that the machine was not located in a staff space, or one, representing that it was located in a staff space.

There are several ways to report outcome measures from regression. One is by using the averages of intercepts, or the average slope of all slopes. The intercept was not used in the point of sale interventions analysis given that the exposure and conditional variables were categorical.

The reported values were the coefficient, where the attached P-value was below or almost on the 5% significance level to reject the null hypothesis, and 95% confidence interval in table form. The coefficient represents the average increase or decrease in percent of red products sold in the group of vending machine locations being looked at, comparing different time periods, and adjusting for repeated measures. The results were also given as plots that included the 95% confidence interval, for visual comparison of the categorical and binary outcome variables.

Finally, the results from the tests for normality already conducted to decide on using t-test or sign test would also be used to determine if any transformation of the data (to normalise it) were needed during the mixed-effects modelling part of the analysis. If the assumptions of normality did not hold, it would be necessary to transform the outcome variable. For example, use natural log of the average weekly number products sold. Further consideration of this potential method of normalisation would have to be considered in more detail if the data were found to be non-normally distributed via the Shapiro-Wilk test, given that mixed model assumptions can still hold even if the data is not normally distributed. In the first instance, if the initial test for normality did hold, no transformation would be necessary.

Linking back to the purpose of this research, a multilevel model allowed the exposures that worked best in the point of sale interventions to be isolated, and a check on whether the conditionals were impacting them in any way to be performed. This insight could then inform policy as proof of the influential aspects of the point of sale design that were impacting on

reducing choice of red products. It might also suggest whether the NHS needs to take more drastic action towards curtailing the level of confectionary and low-ranking products on the nutritional scale, or if the interventions would suffice in meeting policy requirements for them to cut access to unhealthy foods and promoted healthy ones for vending services.

4.7 Staff survey overview

The staff survey covered several catering service improvement agendas. Some of the questions were designed directly in line with the objectives of this research, others covered non-central areas such as patient catering. The survey results were used as the basis for the content of the Trust food and drink strategy as well. It also provided insight into perceptions of the services to make improvements from the FM point of view, in order to reveal weaknesses and opportunities for service change. Questions that linked specifically with this research focused on potential improvement areas of night shift retail options, economic opportunities for improvement, issues of sustainability and nutrition. They also asked about the single out-of-hours retail option of vending amid questions about daytime outlets. Out-of-hours catering was so important as three quarters of hospitals in the NHS do not offer healthy food to staff working night shifts (NHS England 2014).

Gathering baseline data about the service was important, as once the new catering contractor was in place, the results could be re-evaluated to see where improvements have been achieved. It also helped to set a focus for the new contractor to develop their improvement strategies from.

Regarding the research agendas, the survey could contribute to understanding several potential weak points in how catering services are provided to staff, especially out-of-hours. The focus of analysis would be on how the staff use and perceive the services that they receive, rather than on patients. There are several areas of weakness across service communication regarding staff catering. The catering contract, for example, currently asks providers to provide adequate out-of-hours retail options, but does not specify what they are. This is why vending has been chosen as the solution for out-of-hours retail catering for staff, with not enough nutritious options available.

In the non-patient and sourcing sections of the HFSP report, nutrition is only mentioned one sixth as many times as in patient catering, leaving room to set nutritional standards. Without a standard for nutrition to follow, it is natural for staff catering options to lack a clear standard for nutrition, and this includes out-of-hours catering. The guide for staff and visitor catering is unclear about how to provide a nutritious catering service for staff, especially where staff are in ‘excess’ or ‘insufficiency’ of nutrition (two ambiguous terms) (PHE 2014).

The SRA and FFLP audits make limited reference about how to improve catering for staff (Figure 28).

Do you have a vending policy in place to promote healthier eating options for staff, visitors and patients for e.g. unsalted nuts, fresh fruit, unsweetened drinks (please provide evidence)?
Consistent messaging and prominent availability of healthy food throughout the hospital, including access to good food out-of-hours .

Figure 28 SRA audit questions about vending

If it were to be discovered that staff were not receiving adequate food and drink options out-of-hours, it could be a legal and contractual ground for service improvement.

There is a wide range of agendas presented in government policy which a staff survey could help to support and clarify. For example, where nutrition guidance is vague, staff feedback that there is not enough nutrition would support the argument for change. There was a wide scope of information that was being looked at in the staff catering survey, not only the areas mentioned above, but also patient catering, on behalf of dietetics, for example.

The results of the staff survey, conducted through this research, were used directly in the strategy document, as well as the results of the work done to evaluate the DEFRA GBS. Healthier behaviour is being incentivised through the CQUIN 4 for non-patient catering, and supported by the NHS, in the context of preventative measures, particularly targeting issues such as smoking, alcohol consumption and poor diets in healthcare, and encouraging staff lifestyle improvements internally for health and well-being (NHS 2016, Marmot 2010; NHS England 2016 b). Non-patient catering service improvement plans also overlap with preventative models of healthcare such as initiatives to link with the community, health education, and supporting staff, patients and stakeholders in healthcare facilities to make the 'right' choices (WHO 2015, Nice 2016, FFLP 2016, Nice 2015, NHS England 2014, NHS England 2016, Maruthappu 2016 HPH 2015, NHS 2016, NHS England 2016 b.). It was an invaluable snapshot for Barts Health to work on making improvements. The next section goes into detail about the method design.

4.8 Survey hypotheses method and design

The survey aimed to disprove the null hypothesis that:

1. Staff had a positive opinion of hospital vending drinks

This would still raise the question as to whether vending was acceptably healthy but suggest changes may be unpopular.

2. Staff would report using vending less than a few times a month

This would mean that vending does not fulfil its' objective to service staff and so may be ground for removal.

3. Staff, especially night shift staff would report spending less £4 a day on food and drink.

If the null hypothesis could be disproved to show that there were significant odds of night shift staff spending over £4 per day on food, there may be a commercially attractive opportunity to create a better retail catering offering for night shift staff.

4. Staff would perceive vending costs as reasonable.

Disproof of this null hypothesis would show which members of the survey population expected lower priced vending, and help service designers understand the potential reaction to more expensive healthier product options.

5. Night shift staff would report that they receive sufficient nutrition on night shifts

If this was disproved and night shift staff felt that they did not receive sufficient nutrition on night shifts then there would be grounds to use policy guidance and public health funding incentives to argue for service change. This may even potentially be subsidised given there are CQUIN funding opportunities available for healthier eating initiatives for non-patient catering.

6. Night shift staff reporting that they receive sufficient breaks on night shifts.

The analysis sought out statistically significant odds of night shift staff reporting that they received insufficient breaks on night shifts. If staff reported receiving insufficient breaks and the null hypothesis could be disproved, there would be grounds for service change on the basis that their wellbeing was being impacted and could in turn impact their ability to provide care.

7. Night shift staff would report a sufficient ideal catering situation

If the null hypothesis were to be disproved, this would indicate that night shift staff's ideal catering situation was not sufficient. The insufficiency may be regarding the amount, location of breaks, or the nutrition in their diets, this would indicate a need for education of staff about healthy eating habits.

8. Staff do not often get food and drink from outside of the hospital canteen

If the null hypothesis was disproved, it would indicate that retail opportunities to sell food and drink were being lost to retail outlets outside the hospital. This would also indicate that service redesign might bring customers back to hospital retail outlets. If staff were buying food from the vending machines rather than canteens this is equally undesirable as it would indicate the likelihood of poor nutritional intake. The two were grouped together into the same outcome given that they both represent non favourable retail catering situation for the trust.

The results could then be split into demographic information that would ideally help target service improvements. The measured used were about:

What job role best described the member of staff's function within the organisation:

Other (please specify)
Junior Doctor
Facilities Support Staff
Doctor/Consultant
Technical & healthcare support
Manager
Allied Healthcare Professional
Nurse
Admin & Clerical

What site in Barts Health they worked at:

Other (please specify)
Prescot Street
Mile End
Newham University Hospital
St Bartholomew's
Whipps Cross
Royal London

If the usual working time was day, or involved night working
If the usual working environment hospital based or other.

4.8 Staff survey method design

The method design description follows Cresswell (2014). The survey method comes from a post-positivist worldview, meaning that one can identify causes that influence and create a numeric description of trends, attitudes, or opinions of a population by studying a sample of that population, which can be generalised (Cresswell 2014). The design method is discussed in more detail below.

Method:

- Design questions as a collaborative project with the public health department at Barts Health;
- Disseminate survey centrally via staff email and offer a hamper as prize;
- Collect responses automatically via SurveyMonkey;
- Analyse results using logistic regression, allowing one to create meaningful dimensions out of ordinal scale responses;
- Determine key changes that the trust can make to improve vending services and catering for night shift staff.

The purpose of the survey design was to find out staff opinion about and use of food and drink services. The hypothesis was that staff were unsatisfied and reported insufficient provision of nutritional food. The null hypothesis was that staff were satisfied.

The design was chosen to maximise potential responses and make it easy to export responses. It was cross-sectional, although respondents had a few weeks to respond, from the 20th November 2015, to the 9th of December 2015. The population size is approximately 16,000 all staff at Barts Health, which was stratified into the categories shown in Figure 29.

Nurse
Doctor/Consultant
Junior Doctor
Technical & healthcare support
Allied Healthcare Professional
Manager
Admin & Clerical
Facilities Support Staff
Other (please specify)

Figure 29 Job roles addressed in the survey

An email was sent to all staff to participate in the survey and so the sample size was dependent on the number of respondents, making the sample was random. The final total was n=1,292. Respondents came from across Barts Health which included Prescott street, The Royal London, St Bartholomew's, Whipps Cross University, Newham University and Mile End hospitals.

The instrument in the survey was a software called SurveyMonkey. Using an application service provider such as this made the process quicker, cheaper, easier to template according to Barts Health existing practices, and also made the results easy to export to analytics packages. These benefits are typical of online surveys (Sue and Ritter 2011). SurveyMonkey is the regular way that surveys are conducted at Barts Health, and so the added benefit was that staff were used to the procedure.

The survey addresses food and drink services across the entire Trust, from patient catering to out-of-hours retail for staff. A full list of questions can be found in Appendix D.

A range of question types were asked. An example of a multiple choice question is below.

In an average day, what would you usually eat while at work?

- Hot food, bought on site
- Hot food, bought from shop elsewhere
- Hot food, brought from home
- Cold food, bought on site
- Cold food, bought from shop elsewhere
- Cold food, brought from home

Scaler questions were asked about the different retail outlets too, asking staff how they would rate each on a scale of one to five. For example:

- Availability of healthy options (FOOD)
- Availability of healthy options (DRINK)
- Overall quality (FOOD)
- Overall quality (DRINK)
- Amount of information available on nutritional content, including information provided about calories (FOOD)
- Amount of information available on nutritional content, including information provided about calories (DRINK)

This included vending. Finally, some open-ended questions were asked. For example:

'What would you most like to change about food and drink at Barts Health Trust?' Open ended questions were analysed using N-VIVO word frequency output.

To test the survey, a peer review process was undertaken, reflecting on the questions with management in public health, dietetics, and estates and facilities. The policy literature was also consulted. For example, out-of-hours catering is a central concern in policy and so specific questions were asked about this. It was also an area that contracting teams were uncertain about in designing the upcoming tender, and so the results were useful to them in understanding user feedback.

The timeline for the survey was short given that results could be collected electronically. Participants received almost three weeks to complete the survey before it was closed.

The variables in the study are shown in Figure 30.

Variable	Research question	Survey question
Vending	Are staff satisfied	6.,
Night shifts	Are staff nourished	3., 14., 15., 16., 17.
Economic opportunity	Are there profit opportunities in service demand?	5., 6., 7., 8-10.a&b.,
Sustainability	Do people want more ethical products?	11.
Ethnography/Topology	What types of people and places respond how?	1., 2., 3., 4.,
Public health	Are people happy with the nutrition of food overall?	8-10.c-h.,
Opportunity for improvement overall	What do people want to change?	12.

Figure 30 Staff survey variable summary

Only certain questions were included from the survey in analysis, those relating specifically to the concerns around vending, night shift work and those that might be compared to the vending scores as point of reference. Those included are listed in the next sections. Questions about sustainability, patient catering and day shift catering facilities were not analysed. The same methods would apply to these questions and could be performed at a later date for the interest of Barts Health.

4.9 Inferential statistics for survey

For the staff survey, data was collected electronically via Survey Monkey. The member of staff who administrates all staff communication for Barts Health sent an email to the 16,000 members of staff at Barts Health with a link to the survey, and a picture of the hamper they might win for participating.

The data was exported form SurveyMonkey in long format in the first instance. Codes were created for the dataset, swapping string variables with numerical. For example, a question about rating the food in vending machines asked for respondents to rate the food from 1 (Poor) to 5 (Excellent). They rated it on the availability of healthy options (FOOD), overall quality (FOOD) and finally, the amount of information available on nutritional content, including information provided about calories (FOOD).

There was another question relating to the price of food. However, this was not analysed separately as it relates to the underlying metric of money rather than nutrition. Both were included in the analysis, only grouped as separate dimensions.

The responses were changed to purely numerical values of 1, 2, 3, 4 and 5. This numerical dataset was later required to set dimensions for each question. If a respondent answered 3 or less, for example, as to what they thought of vending, the response was placed in the dimension ‘vendFoodBad’==1. If they answered 4 or 5, ‘vendFoodBad’==0. These dimensions were then used in the further analysis. The logic and process behind this is explained in more detail below.

Creating dimensions allowed for meaningful analysis that linked the responses to the hypothesis questions about how staff felt about catering. If an ordinal scale had been kept instead of using a binary approach, the difference between 1 and 2 would be quite small and it would be difficult to extrapolate any conclusions from their comparison. Using thresholds that separate responses into ≤3 and ≥4 gives a clear cut off to indicate the acceptable level of opinion before it becomes clear the respondent's views fall below service standards. The new dimension gave a clear differential between good versus bad opinions where an ordinal scale could not. The threshold of 3 and below was chosen, and this includes the negative options of 1 and 2, as well as the indifferent (which is also not favourable).

The approach was based on finding and analysing negative feedback. Positive feedback was taken to mean that there was not a problem and was used as support of the null hypothesis:

Staff opinion is positive, there is no problem and do nothing.

Choosing the threshold based on this logic of finding non-positive responses gave the dimensions inherent and straightforward logic one can see in the formation of each dimension.

Each dimension might include several questions. For example, to create a dimension that added up all the negative responses to staff’s opinion of vending food, the focus was on nutrition and health of the food or drink. A separate dimension was used to summarise opinion of vending costs, given that this is fundamentally different from opinions about nutrition. The vending food

dimension was nicknamed ‘vendFoodBad’, which means, respondents indicated they felt vending food was bad if they responded ≤3 to the following questions about:

Availability of healthy options (FOOD)
Overall quality (FOOD)
Amount of information available on nutritional content, including information provided about calories (FOOD)

If the response was ≤3 and was not left blank for any of these questions, the respondent was counted as 1 in the ‘vendFoodBad’ dimension. If the response for all three questions was ≥4 the value of 0 was attributed to the dimension. Each respondent’s answers were added up to create the total for this dimension. ‘vendFoodBad’ would be equal to the number of respondents falling who were given a value of 1. The same type of questions were asked for vending drinks. For a full list of dimensions see Appendix E.

Once the dimensions had been created, the number of people who thought different aspects of the catering services were bad could be counted. The large sample (n=1292) made it possible to perform meaningful analysis.

The type of data created is suited to performance of a chi-squared test. This allows one to assess the relationship between two categorical variables (Lewis-Beck et al 2003).

The chi-squared test equation is:

Chi-squared test equation

$$X^2 = \sum \frac{(f_0 - f_e)^2}{f_e}$$

This type of analysis is appropriate where the data is about counting people, in this case the number of people who responded ‘vendFoodBad’ (a number ≤3) to the corresponding questions. This kind of data is binary and so requires the reporting of the odds ratio, rather than a coefficient value for analysis. It allows one to understand the factors that predict an event. In this case the predictive factors that were being understood were ‘Shift time’, which was split into two. The first was Daytime and second included both night time or a mix of day and night. ‘Work environment’ was another independent variable, it was split into Other, Out in the community, Office or Hospital. There were also two more independent factor variables predicting response. These were ‘Job Role’, with nine different job roles including, for example, an administrative and clerical role, which was used as the baseline, and nurses. There was also ‘Work Site’, with seven sites including the administrative offices of Prescot Street, which were also used as the baseline, and others such as the Royal London Hospital.

Using binary outcome variables, and the categorical predictor (independent) variables listed above, the chi-square test could be used as the foundation to build a logistical regression model.

Regression assumes:

$$Y = a$$

In regression, a is the intercept and Y is the outcome. Y is a negative or unwanted opinion that represents a negative aspect of the current vending and night shift service, represented by the value 1 for each question. If Y was equal to zero it represented a positive opinion and was not of interest in the analysis.

For non-linear regression, a binary outcome (2levels counting) includes:

$$+ C * shift\ time$$

Shift time could be zero, representing day shift workers, or one, representing night shift workers. Again, as with the linear regression used for the point of sale intervention analysis, one is the variable of interest, zero is the comparator. In this case, C is the odds ratio (log scale) of Y (eg. positive negative opinion) for day compared to night shift. EG if OR=0.75, then the risk of having a negative opinion in night shift is 25% lower than the risk for day shift workers.

In non-linear regression, a categorical (≥3 levels) includes:

$$+ D * worksite$$

There are seven potential worksites labelled zero through six, Prescott Street, the administrative offices, were used as a baseline. Categorical variables describing administrative roles were used as the baseline throughout. D is the odds ratio (log scale) of Y (eg negative opinion) between the reference group which you choose (e.g. admin Prescot Street) and each of the other categories with the same intercept as C.

The mathematical equation for a logistic regression is:

Logistic regression equation

$$logit(p) = log\left(\frac{p}{1} - p\right) = a + bX_1 + cX_2 + dX_3 + \cdots$$

Using a logistic regression in the binary case (eg. vendingFood = 1 or 0), allows one to adjust for confounders where looking at a single factor like the job role of nurse or night shift. For example, one can check if being a night shift worker gives one a higher probability of being dissatisfied with vending machine food and drink.

4.10 Conclusion

The methodology of this research was drawn a from mixed methods approach, using quantitative analysisas well as identifying with a grounded theory approach to build from the actual situation (Patton 2015, Robson 1991, Tashakori and Teddlie 2010). The methodology had to fit the research project, the industry demand for change, and work for change from within the system (Patton 2015, Robson 1991, Wagner et. al. 2011, O'Brien 2014). Broadly, the existing service measures in place fit a traditionally quantitative set of approaches, while the service evaluation methods and quality checks, scoping and consultancy, were broadly qualitative (Schedler 2004, Rose and Cray 2010, Coakley et al 2014, Morgan 2007). Finally, the sampling strategy uses a multiple case sampling method, prioritising qualitative information for service improvement, with primary, quantitative research, to back up and elaborate on critical aspects of service delivery (Tashakori and Teddlie 2010).

Chapter 5 Results

This chapter details the statistical results of the survey and point of sale intervention. In each instance, the descriptive are given before the inferential results. Results are presented in tables that detail the significant results and then illustrate then in a diagram.

5.1 Descriptive results survey

The results of the survey have been given here in two population sizes: either all the staff who responded or only those who responded that they were working night shifts or a mixture of night and day shifts. Where results are significant both are given.

The survey questions were summarised into dimensions, grouping responses together and assigning them a binary value of either 0 or 1, to demonstrate how they combine to relate to the overall interests and hypotheses of the survey. For example, the first summary tables in Figure 31 and Figure 32 describe three of the dimensions which link vending services to nutrition and healthy eating and then vending to prices of products. The first dimensions summarised in Figure 31 contain questions asking respondents to rate 'Availability of healthy options', 'Overall quality' and 'The amount of information available on nutritional content, including information provided about calories' between 1. (Poor) and 5. (Excellent). The following table summarises the dimension for questions about vending prices. The diagram in Figure 33 displays the detailed results for each question. Respondents had to have given a score of 3 or less to at least one of the questions to be counted as a 'yes' in the tables below. This was interpreted to mean that they had a negative opinion of vending in regards to food or drink.

Gave vending food a score of 3 or less out of a possible 5 for all staff		
All staff	Freq.	Percent
No	480	37
Yes	812	63
Total	1,292	100
Gave vending food a score of 3 or less out of a possible 5 for night staff		
Night staff	Freq.	Percent
No	16	9
Yes	154	91
Total	170	100
Gave vending drinks 3 or less points out of 5 for all staff		
All staff	Freq.	Percent
No	334	26
Yes	958	74
Total	1,292	100
Gave vending drinks 3 or less points out of 5 for night staff		
Night staff	Freq.	Percent
No	20	12
Yes	150	88
Total	170	100

Figure 31 Vending opinion frequencies represented as those who gave vending food a score of 3 or less out of a possible 5

Over half of all staff respondents gave vending food a score of 3 or less and almost three quarters gave the same response for vending drinks. In comparison, 91% of night shift staff gave vending food a score of 3 or less and 88% gave the same response for food.

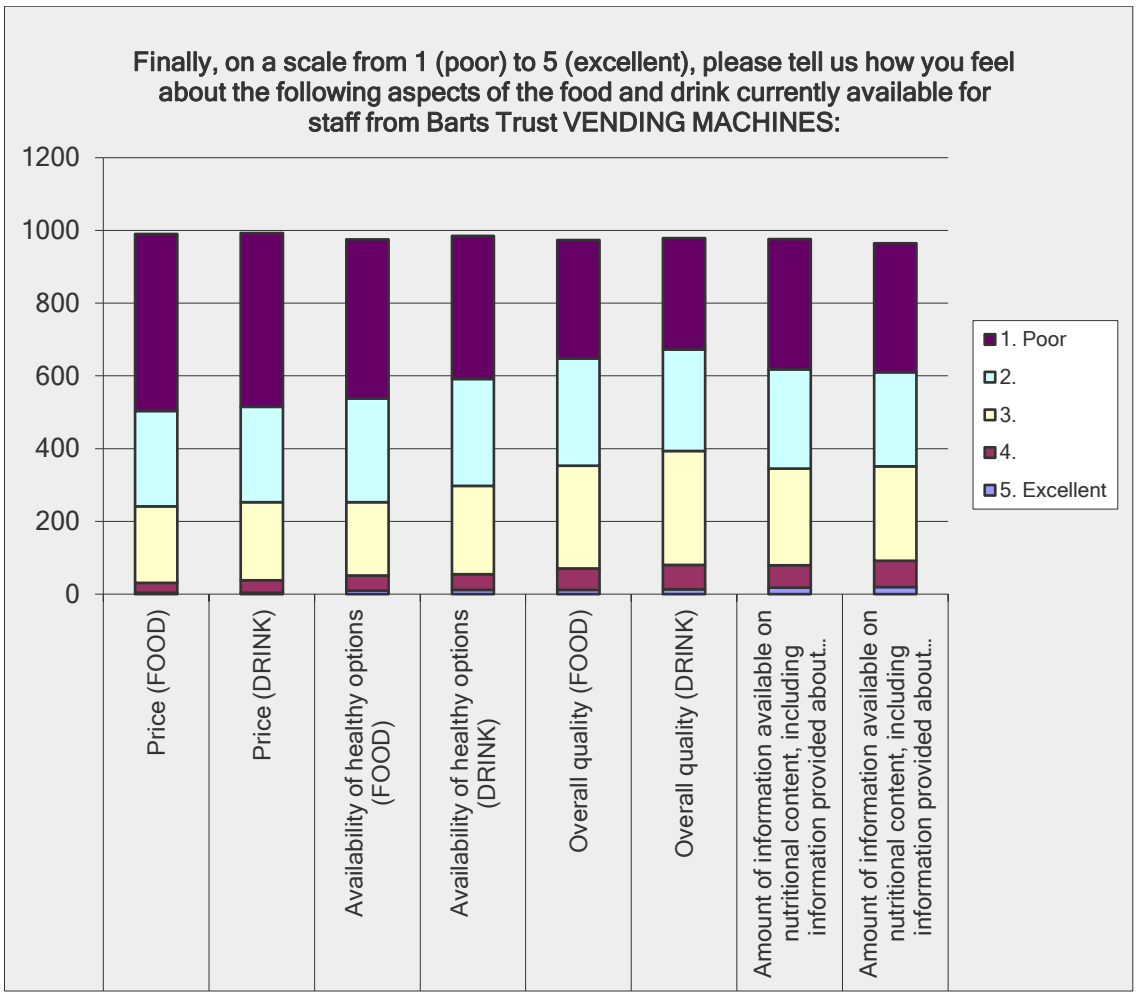
When asked to rate the cost of vending food and drink between 1. (Poor) and 5. (Excellent), a similar trend arose, with night shift staff being far more negative about the service (Figure 32).

Do you feel that vending prices are too high?		
All staff	Freq.	Percent
No	326	25
Yes	966	75
Total	1,292	100
Night shift	Freq.	Percent
No	16	9
Yes	154	91
Total	170	100

Figure 32 Felt that the vending prices were too high

This shows a 16% increase in staff who felt the price of vending was too high among night shift workers, when compared to the total survey responses.

The responses to questions about vending were plotted on a graph (Figure 33) to display the results directly from the survey responses.



n=1001

Figure 33 Graph of responses to questions about vending

This shows that there were very few scores 4 or 5 for vending services across the range of possible questions asked. The next summary tables describe how often staff reported using vending machines in the Barts Health Hospitals. If they selected the option 'A few times a month', 'A few times a week', or 'Every day', they were counted in the summary tables in Figure 34 as a 'yes'.

Do you use vending more than a few times a month?		
All staff	Freq.	Percent
No	898	79
Yes	242	21
Total	1,140	100
Night Staff	Freq.	Percent
No	99	64
Yes	56	36
Total	155	100

Figure 34 Reported using hospital vending more than a few times a month

These tables show that the reported use of vending was 15% higher among night shift staff participating in the survey. This means that night shift are both using vending most and are also most dissatisfied with the service compared to day shift staff.

Splitting the night shift staff from all staff during the data analysis was especially important when considering the questions specifically about night shift catering. The results below only include night shift responses as a result.

Respondents were asked:

'Please tell us about WHAT you currently eat and drink during a usual night shift and any differences between this and what you would ideally like to eat and drink during these shifts (tick as many boxes as apply to you).'

If they responded to at least one of the options to say that they ate snacks or had no food, drank fizzy or fruit drinks or drank none at all, this was deemed insufficient. It indicated that staff do not eat a full meal and only had drinks that would score as red in the nutritional profile. Snacking was not felt to be sufficient. Similarly, the French government campaigned against snacking as part of the PNNS as it is widely accepted to be associated with poor food choices of confectionary and crisps (Ungureanu et al 2014, Chauliac and Hercberg 2012, Martin and Chauliac 2014, Dubuisson et al. 2012, (French ministry of health 2012). Other responses of a hot or cold meal, a hot drink, mineral water, or tap water were excluded from the dimension.

Night Shift	Freq.	Percent
Indicated that they are receiving sufficient food or drink during night shifts	64	38
Indicated that they are receiving insufficient food or drink during night shifts	106	62
Total	170	100

Figure 35 Indicated that they are receiving insufficient food or drink during night shifts

This reveals that 62% of night shift workers report receiving insufficient food or drink options whilst working.

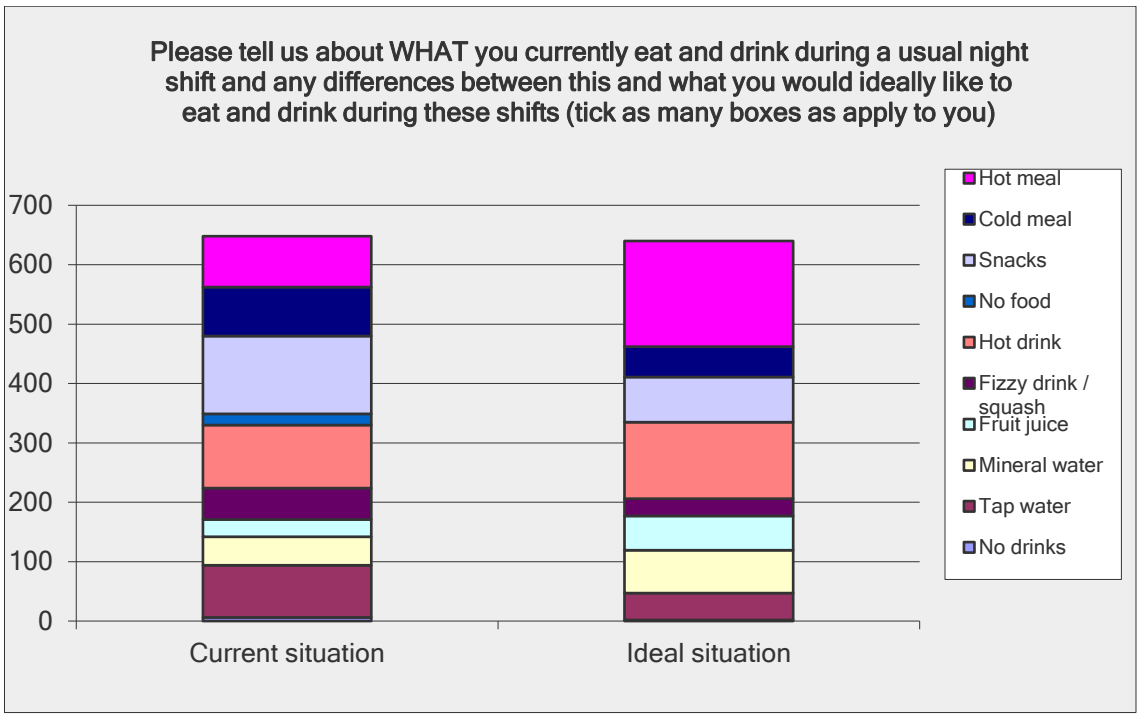
To check if the staff would prefer something different, they were asked the same questions but this time about their ideal, rather than current situation.

Night shift	Freq.	Percent
Their ideal situation qualified as sufficient food or drink during night shifts	58	34
Their ideal situation qualified as insufficient food or drink during night shifts	112	66
Total	170	100

Figure 36 Indicated that they would ideally be receiving insufficient food or drink

This shows that 66% of staff would ideally want to have either no food or drink, snacks, fizzy or fruit drinks during their shift.

This result was displayed in a graph (Figure 37), to highlight that staff's ideal situation was similar to their current situation, but that this may indicate a training and food education requirement rather than a positive outcome. For example, many staff's ideal situation would be to have no food at all, which would be an unhealthy option.



Current situation n=225
Ideal situation n=215

Figure 37 Graph of what staff currently eat and drink on night shift

The graph does show that more staff would ideally like a hot meal than are currently receiving one.

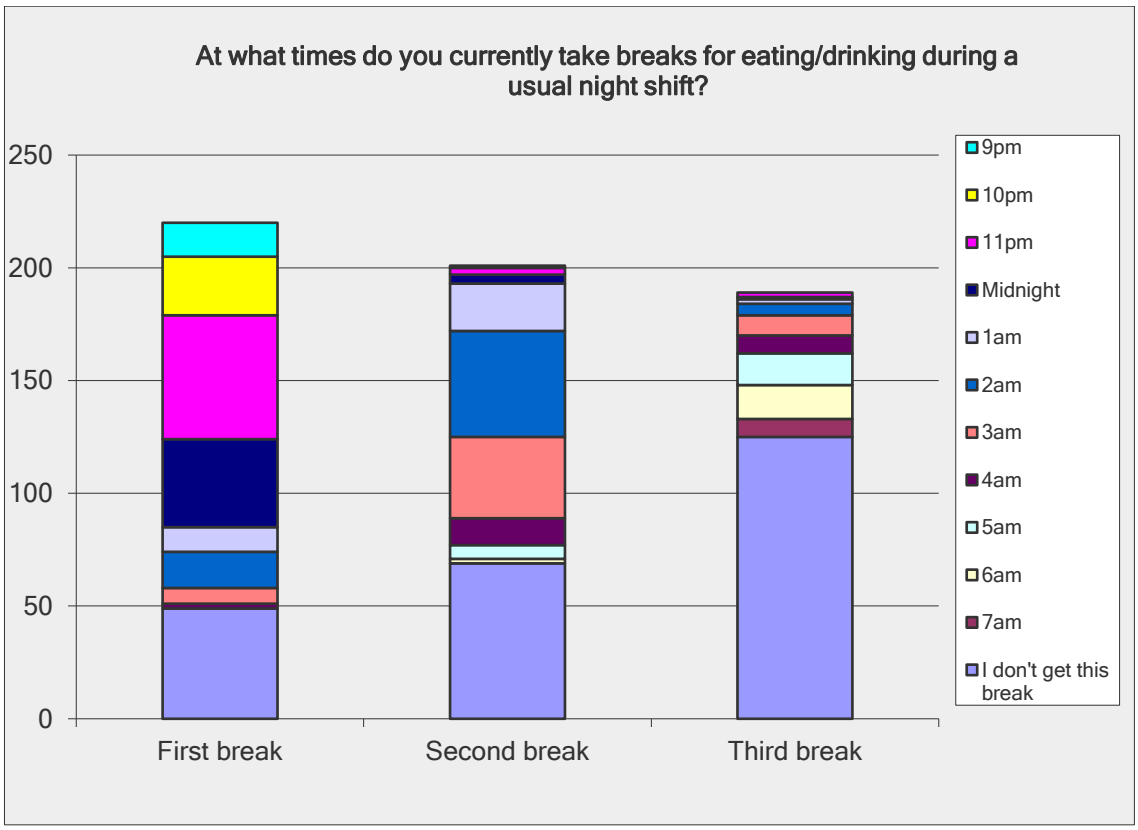
Staff were also asked where they currently eat their meals while on night shift and if they receive their three allotted breaks. If respondents selected that they took a break in a hospital canteen, café, in an area outside the hospital or anywhere other than their work stations, this was deemed adequate. If they selected on the ward, in a staff kitchen or that they did not receive one of their three allotted breaks, this was deemed inadequate.

Night Shift	Freq.	Percent
Indicated that they are receiving sufficient breaks during night shifts	28	16
Indicated that they are receiving poor breaks during night shifts	142	84
Total	170	100

Figure 38 Night staff who Indicated that they are receiving poor breaks during night shifts

This shows that 84% of night shift staff report that they do not have adequate space to have their breaks in.

Within this result, it was broken down further to highlight the amount of staff not receiving breaks (Figure 39).

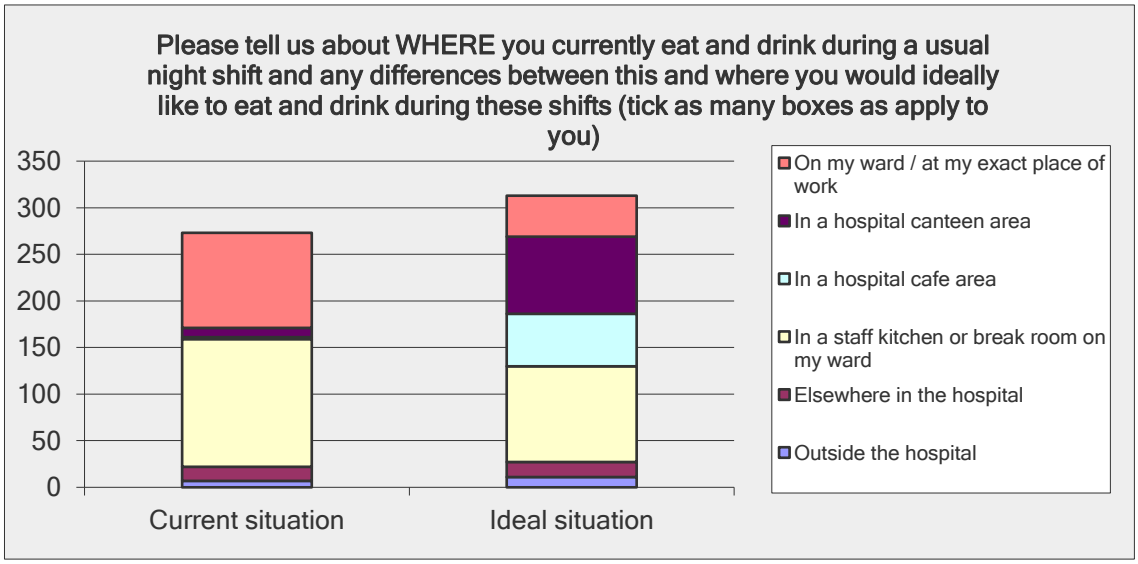


n=222

Figure 39 Graph of staff break times

The staff on night shifts who do not get the first, second or third break are highlighted in purple at the bottom of each bar.

The difference between where staff currently and ideally would take their breaks was also made into a graph to show how many night shift staff would change their current situation (Figure 40).



Current situation n=226
Ideal situation n=214

Figure 40 Graph of where food and drink is eaten on night shift

The next descriptive statistics summarise potential upsell opportunities.

Night shift	Freq.	Percent
Bought/brought in food from outside the hospital less than a few times a month	49	29
Bought/brought in from outside the hospital more than a few times a month	121	71
Total	170	100

Figure 41 Night shift who bought brought in food from outside the hospital more than a few times a month

71% of night shift staff were sourcing their food from retail outlets outside of the hospital (Figure 41), indicating that competing businesses take a large proportion of potential catering revenue. At the same time, the number of night shift staff who spend above £4 was significantly high, at 58%, enhancing the potential revenue indicated (Figure 42).

Night shift	Freq.	Percent
Spend above £4 on retail outside the hospital less than a few times a month	72	42
Spend above £4 on retail outside the hospital more than a few times a month	98	58
Total	170	100

Figure 42 Spend above £4 on retail outside the hospital more than a few times a month

Finally, many night shift staff indicated that they do not use the hospital retail facilities to purchase meals for their shifts.

The table in Figure 43 shows frequencies for those who bought food and drink for their night shifts from either vending machines or outside of the hospital.

Night shift	Freq.	Percent
Food purchases from canteen	25	15
Food purchases outside of canteen	145	85
Total	170	100

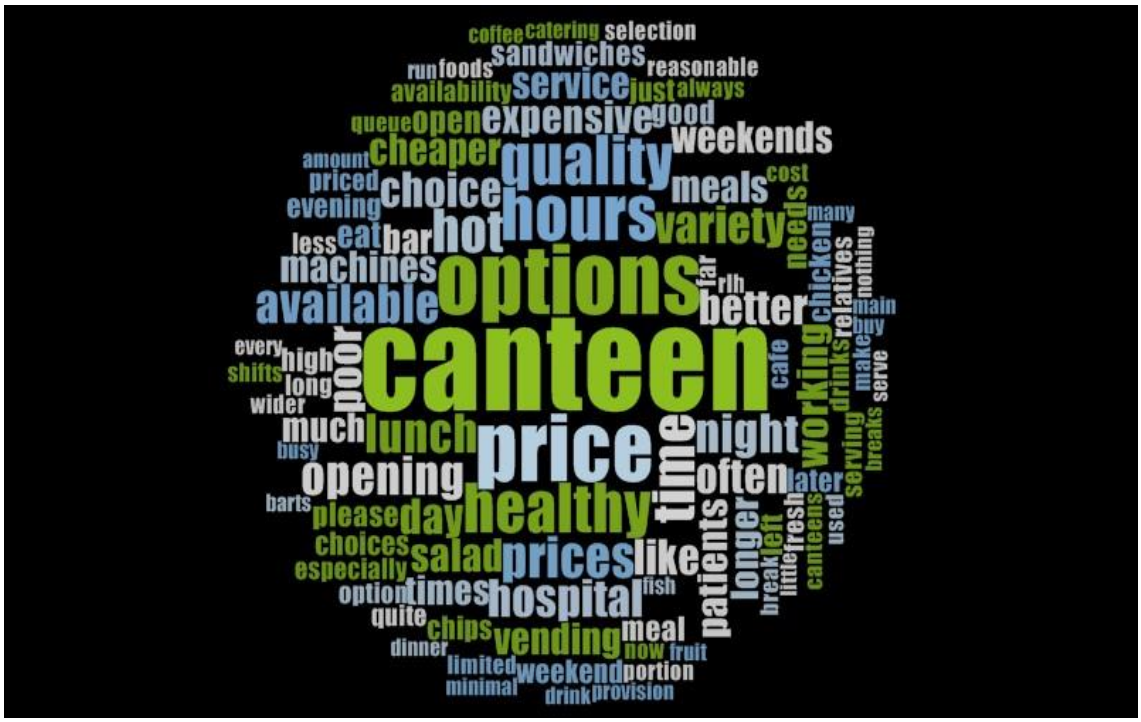
Figure 43 Night shift food purchases outside of canteen

85% of night shift staff either only purchase vending confectionary snacks or drinks, or do not purchase anything at all from the hospital during their shifts.

5.2 Open response descriptive results for the staff catering survey

The following results have been summarised as word frequency diagrams, to summarise the main responses to the question ‘What would you most like to change about food and drink at Barts Health Trust?’. The top 100 words were included, and the words ‘food’, ‘got’ and ‘already’ were excluded given their high frequency of occurrence and lack of helpfulness in understanding the responses linked to the question.

The diagram in Figure 44 represents all staff:



(n=1114)

Figure 44 All staff word frequency for what they would change about food and drink

Word	Count
price/prices/priced	45
canteen	45
options	30
hours	22
healthy	20
quality	20
time	18
hot	17
prices	16
available	15

The top ten words mentioned were:

Figure 45 Top ten-word frequency for night staff

The second diagram in Figure 46 represents night shift staff.

(n=170)

Figure 46 Night staff word frequency for what they would change about food and drink

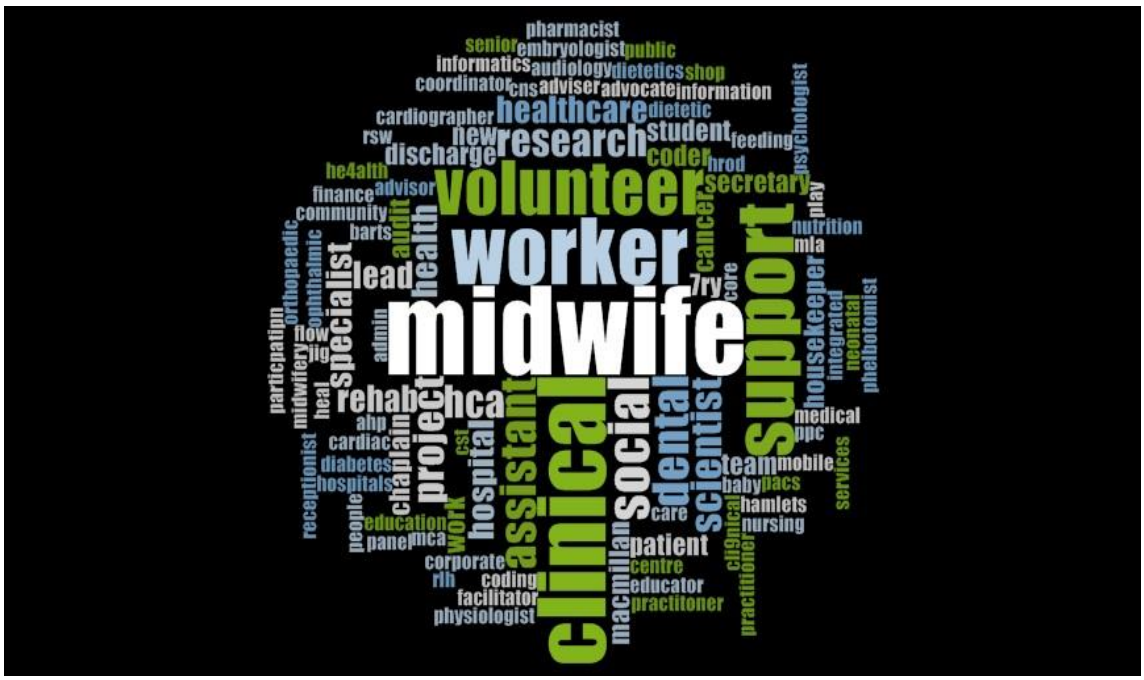
The top ten words mentioned were:

Word	Count
Price/ prices/priced	427
options	305
canteen	297
healthy	194
quality	181
better	172
expensive	170
	166
variety	150
salad	119

Figure 47 Top ten-word frequency for night staff feedback

In response to what worksite, job and work environment staff had, they could respond ‘other’. These ‘other’ responses were also placed into word frequency diagrams to summarise the responses given (Figure 46).

Response ‘other’ for ‘What role best describes your function within your organisation?’ shown below.



Response ‘other’ for ‘What is your usual working environment?’ shown below.

Response ‘other’ for ‘What is the main Barts Health Trust site you work at?’ shown below.

Figure 48 Word frequencie diagrams for respondents who answered other for any question

5.3 Introduction to inferential results for staff catering survey

This section shows results of the logistic regression modelling for the staff survey. Before beginning with the inferential results, a few notes on the structure. Firstly, the full results tables and graphs are given in Appendix F. Finally, night shift staff refers to staff working both mainly night shift and a mixture of both night and day shifts.

Results of analysis of survey responses to vending as a whole

Odds of having a negative opinion of hospital vending food					
	proportion	OR	P-value	(95% CI)	
shift time					
day	0.72				
night	0.91	4.22	0.00	2.25	7.94
Overall P-value for shift time (p<0.001)					
main worksite					
Other (please specify)	0.72	1.48	0.48	0.51	4.33
Prescot Street	0.64	1.00			
Mile End	0.58	0.79	0.58	0.34	1.83
Newham University Hospital	0.80	2.41	0.04	1.03	5.65
St Bartholomew's	0.73	1.59	0.26	0.71	3.58
Whipps Cross	0.69	1.27	0.56	0.57	2.81
Royal London	0.81	2.58	0.02	1.19	5.56
Overall P-value for worksite (p<0.001)					

Figure 49 Odds of having a negative opinion of hospital vending food

There was strong evidence at the 5% significance level to reject the null hypothesis that there was no overall effect between predictor variables of shift time (p<0.001) and work site (p<0.001) on the odds of having a negative opinion of hospital vending food. The odds of staff at the Newham University Hospital site having a negative opinion of hospital vending food was 141% higher and 158% higher at the Royal London Hospital site than staff at the administrative offices at Prescott Street, after adjusting for the other factors.

In particular, the odds of night shift staff having a negative opinion of hospital vending food was 322% higher than day shift staff, after adjusting for the other factors. The graph in Figure 50 illustrates the proportions for each.

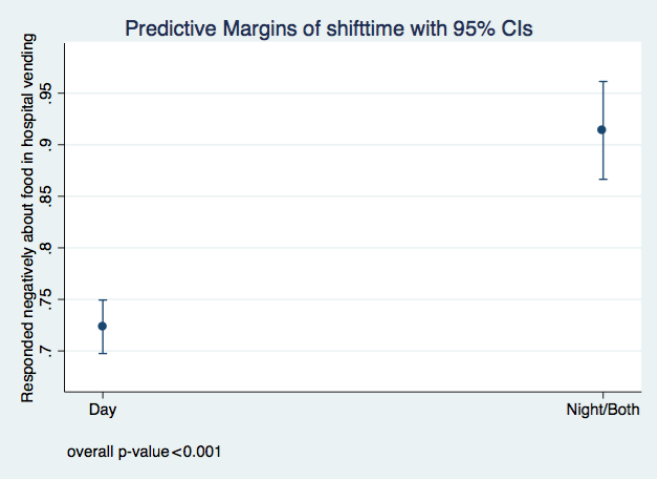


Figure 50 Graph of odds of having a negative opinion of hospital vending food by shift time

The dot shows the odds of day vs night shift responding negatively about the food in hospital vending. The vertical line represents the 95% confidence interval. All the diagrams follow the same layout.

Odds of having a negative opinion of hospital vending drinks					
	proportion	OR	P-value	(95% CI)	
shift time					
day	0.72				
night	0.88	3.03	0.00	1.72	5.34
Overall P-value for shift time (p<0.001)					
main worksite					
Other (please specify)	0.69	1.50	0.46	0.52	4.33
Prescot Street	0.60	1.00			
Mile End	0.58	0.92	0.86	0.40	2.15
Newham University Hospital	0.80	2.73	0.02	1.17	6.40
St Bartholomew's	0.73	1.87	0.13	0.83	4.21
Whipps Cross	0.68	1.42	0.39	0.64	3.16
Royal London	0.82	3.04	0.01	1.40	6.58
Overall P-value for worksite (p<0.001)					

Figure 51 Odds of having a negative opinion of hospital vending drinks

Similar to hospital vending food, there was strong evidence at the 5% significance level to reject the null hypothesis that there was no overall effect between predictor variables of shift time (p<0.001) and work site (p<0.001) on the odds of having a negative opinion of hospital vending food. The odds of night shift staff having a negative opinion of hospital vending food was 202% higher than day shift staff, after adjusting for the other factors.

The odds of staff at the Newham University Hospital site having a negative opinion of hospital vending food was 173% higher and 204% higher at the Royal London Hospital site than staff at the administrative offices at Prescott Street, after adjusting for the other factors. The graph in Figure 52 illustrates the proportions for each.

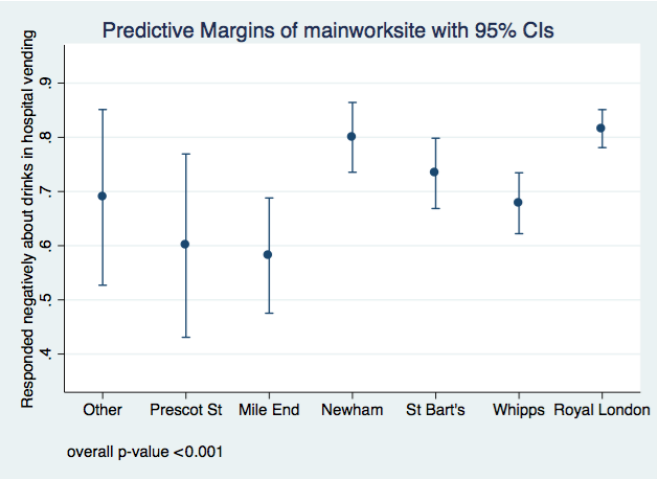


Figure 52 Graph of odds of having a negative opinion of hospital vending food by worksite

Odds of using vending a few times a month or more					
	proportion	OR	P-value	(95% CI)	
shift time					
day	0.19				
night	0.32	1.99	0.00	1.32	3.01
Overall P-value for shift time (p<0.001)					
job role					
Other (please specify)	0.21	1.22	0.52	0.66	2.26
Junior Doctor	0.14	0.75	0.59	0.26	2.13
Facilities Support Staff	0.34	2.44	0.10	0.86	6.95
Doctor/Consultant	0.26	1.63	0.20	0.78	3.42
Technical & healthcare support	0.34	2.53	0.01	1.28	5.02
Manager	0.12	0.61	0.16	0.31	1.22
Allied Healthcare Professional	0.21	1.21	0.78	0.75	1.96
Nurse	0.26	1.66	0.03	1.05	2.60
Admin & Clerical	0.18	1.00			
Overall P-value for job role (p<0.001)					

Figure 53 Odds of using vending a few times a month or more

There was strong evidence at the 5% significance level to reject the null hypothesis that there was no overall effect between predictor variable of shift time (p<0.001) and the odds of using vending a few times a month or more. There was good evidence at the 5% significance level to reject the null hypothesis that there was no overall effect between predictor variable of job role (p<0.02) and the odds of using vending a few times a month or more. The odds of technical healthcare support of using vending a few times a month or more was 153% higher and 66% higher for nurses compared to administrative or clerical staff, after adjusting for the other factors. The graph in Figure 54 illustrates the proportions for each.

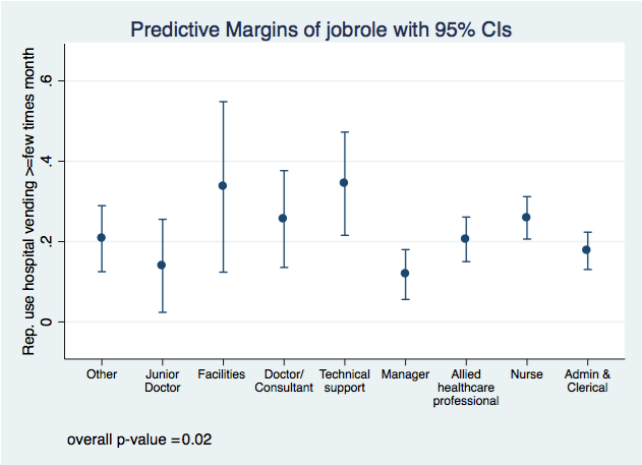


Figure 54 Graph of odds of using vending a few times a month or more by job role

The odds of night shift staff using vending a few times a month or more was almost twice as high compared to day shift staff, after adjusting for the other factors. The graph in Figure 55 illustrates the proportions for each.

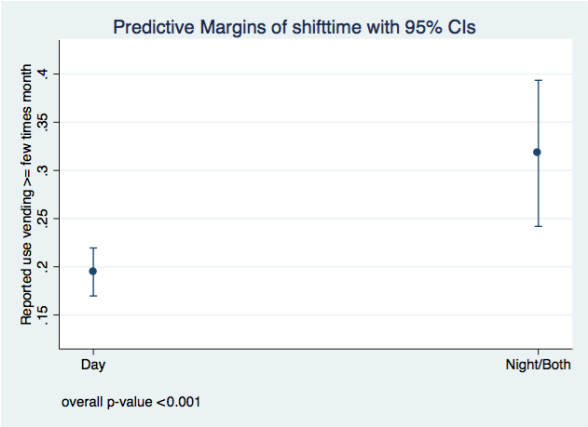


Figure 55 Graph of odds of day shift workers using vending a few times a month or more compared to night shift workers

The next few questions are finance-related questions.

Odds of spending over £4 a day on food and drink or more					
	proportion	OR	P-value	(95% CI)	
main worksite					
Other (please specify)	0.46	1.33	0.58	0.48	3.71
Prescot Street	0.39	1.00			
Mile End	0.49	1.51	0.33	0.66	3.45
Newham University Hospital	0.51	1.64	0.22	0.74	3.63
St Bartholomew's	0.65	2.93	0.01	1.34	6.40
Whipps Cross	0.53	1.80	0.14	0.83	3.89
Royal London	0.62	2.64	0.01	1.25	5.54
Overall P-value for work site (p<0.001)					
job role					

Other (please specify)	0.51	0.97	0.89	0.62	1.52
Junior Doctor	0.52	0.99	0.98	0.45	2.19
Facilities Support Staff	0.74	2.72	0.06	0.95	7.81
Doctor/Consultant	0.62	1.53	0.19	0.81	2.88
Technical & healthcare support	0.64	1.66	0.11	0.90	3.07
Facilities Support Staff Manager	0.68	1.99	0.00	1.28	3.08
Allied Healthcare Professional	0.52	1.02	0.92	0.72	1.45
Nurse	0.61	1.48	0.03	1.05	2.09
Admin & Clerical	0.52	1.00			
Overall P-value for job role (p=0.01)					

Figure 56 odds of spending over ay on food and drink or more or more shi

There was strong evidence at the 5% significance level to reject the null hypothesis that there was no overall effect between predictor variable of main work site (p<0.001) and the odds of spending over £4 a day on food and drink or more. There was good evidence at the 5% significance level to reject the null hypothesis that there was no overall effect between predictor variable of job role (p<0.02) and the odds of spending over £4 a day on food and drink or more. The odds of St Bartholomew's Hospital staff spending over £4 a day on food and drink or more was nearly three times higher and just over one-and-a-half times higher for Royal London Hospital staff compared to staff at the administrative offices at Prescott street, after adjusting for the other factors. The graph Figure 57 illustrates the proportions for each.

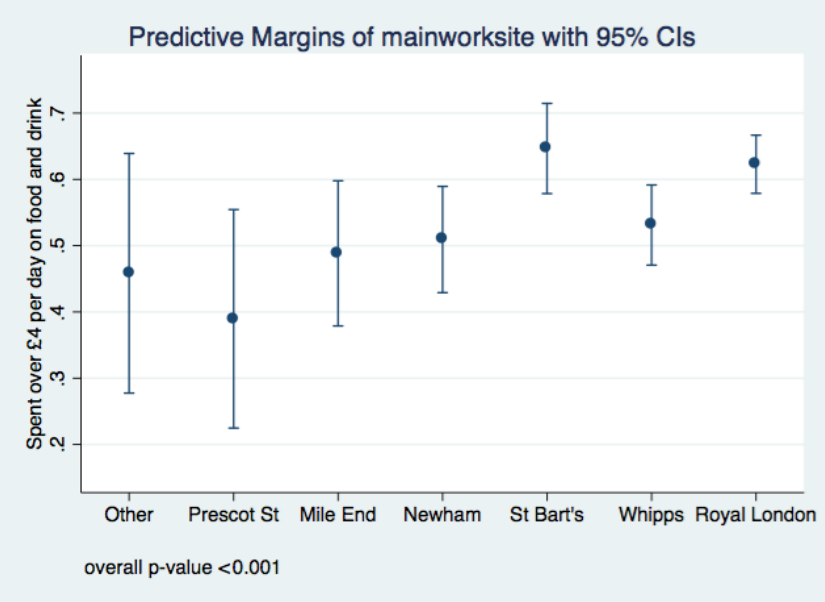


Figure 57 Graph of odds of spending over ces at Prescott street more shift timee worksit

The odds of facilities support staff spending over £4 a day on food and drink or more was 172% higher than administrative and clerical staff. For managers it was almost twice as high, and, finally, for nurses it was almost one-and-a-half times higher, after adjusting for the other factors. The graph in Figure 58 illustrates the proportions for each job role.

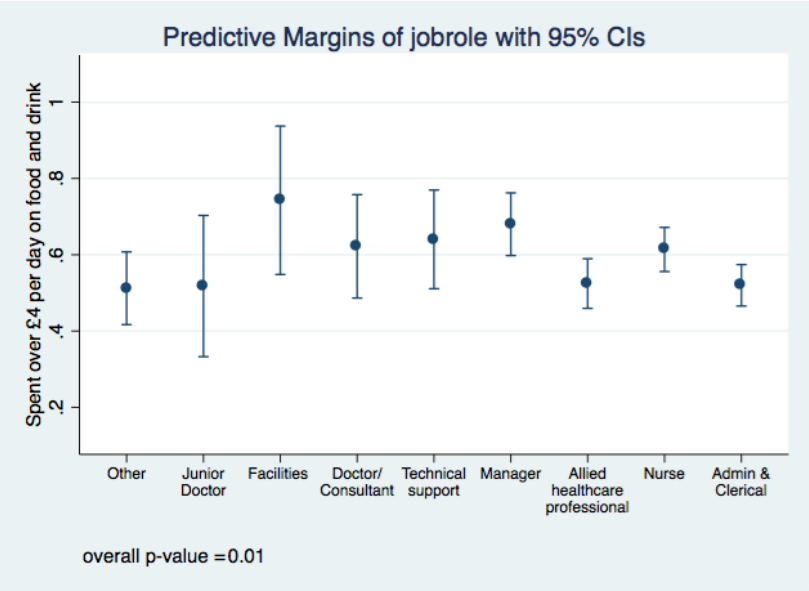


Figure 58 Odds of perceiving vending costs as high

Odds of perceiving vending costs as high					
shift time	proportion	OR	P-value	(95% CI)	
day	0.73				
night	0.91	4.00	0.00	2.13	7.53
Overall P-value for shift time (p<0.001)					
main worksite					
Other (please specify)	0.72	1.30	0.63	0.44	3.79
Prescot Street	0.67	1.00			
Mile End	0.59	0.69	0.39	0.30	1.61
Newham University Hospital	0.83	2.36	0.05	1.01	5.55
St Bartholomew's	0.77	1.62	0.24	0.72	3.65
Whipps Cross	0.66	0.95	0.91	0.43	2.10
Royal London	0.81	2.15	0.05	1.00	4.61
Overall P-value for main worksite (p=0.01)					

Figure 59 Table of odds of perceiving vending costs as high

There was strong evidence at the 5% significance level to reject the null hypothesis that there was no overall effect between predictor variables of shift time (p<0.001) on the odds of perceiving vending costs as high. There was good evidence at the 5% significance level to reject the null hypothesis that there was no overall effect between predictor variable of work site (p=0.01) and the odds of perceiving vending costs as high.

The odds of night shift staff perceiving vending costs as high was four times higher than day shift staff, after adjusting for the other factors. The graph in Figure 60 illustrates this further.

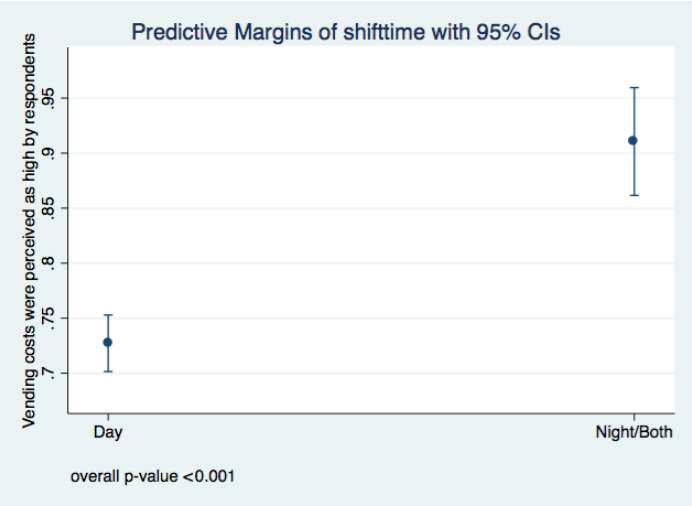


Figure 60 Graph of odds of perceiving vending costs as high by shift time

The odds of staff at the Newham University Hospital site having a negative opinion of hospital vending food was 136% higher and 115% higher at the Royal London Hospital site than staff at the administrative offices at Prescott Street, after adjusting for the other factors. The graph Figure 61 illustrates the proportions for each.

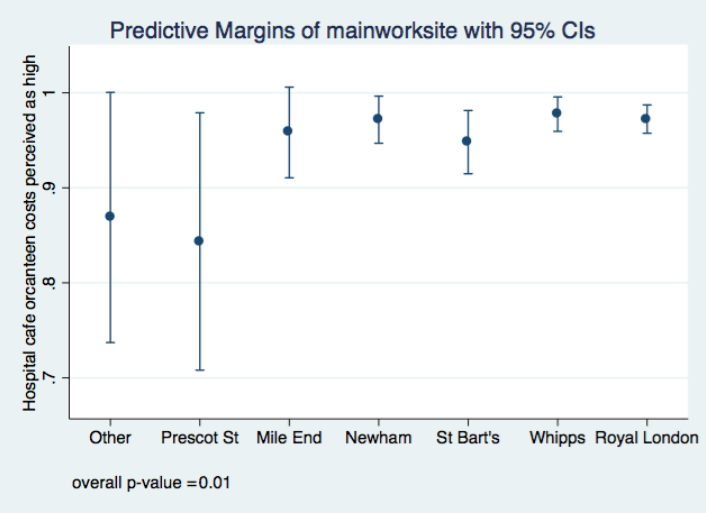


Figure 61 Graph of responses for vending costs were perceived as high by main worksite

The final section of the inferential statistics for the survey results focuses on questions about night shifts. It is supposed that night shift rely most heavily on vending for food and drink whilst working, given that there are no other retail outlets open on site.

As would be suspected, working night shifts was a significant predictor in each case. For each of the questions in the following section, there was strong evidence at the 5% significance level to reject the null hypothesis that there was no overall effect between predictor variables of shift time ($p<0.001$) on the odds of night shift staff reporting a poor ideal catering situation. The odds of night shift staff reporting a poor ideal catering situation is inherently likely to be higher, as the question requested that only night shift staff respond, and so day shift staff are unlikely to have answered the question.

Table of the odds of night shift staff reporting that they receive poor nutrition on night shifts					
	proportion	OR	P-value	(95% CI)	
shift time					
day	0.05				
night	0.53	26.47	0.00	16.34	42.89
Overall P-value for shift time (p=0.01)					
job role					
Other (please specify)	0.11	1.42	0.49	0.53	3.78
Junior Doctor	0.17	3.24	0.07	0.93	11.28
Facilities Support Staff	0.08	0.82	0.87	0.07	9.18
Doctor/Consultant	0.15	2.58	0.10	0.85	7.82
Technical & healthcare support	0.12	1.68	0.39	0.51	5.51
Manager	0.07	0.78	0.68	0.24	2.52
Allied Healthcare Professional	0.12	1.77	0.19	0.75	4.17
Nurse	0.16	2.96	0.00	1.41	6.25
Admin & Clerical	0.09	1.00			
Overall P-value for job role (**p=0.06**)					

Figure 62 The odds of night shift staff reporting that they receive poor nutrition on night shifts

There was strong evidence at the 5% significance level to reject the null hypothesis that there was no overall effect between predictor variable of job role (p=0.06) and the odds of staff reporting that they receive poor nutrition on night shifts.

Odds of night shift staff reporting that they receive poor breaks on night shifts					
	proportion	OR	P-value	(95% CI)	
shift time					
day	0.08				
night	0.80	72.06	0.00	40.04	129.70
Overall P-value for shift time (p < 0.001)					
job role					
Other (please specify)	0.18	2.04	0.12	0.82	5.06
Junior Doctor	0.33	7.77	0.00	2.43	24.83
Facilities Support Staff	0.22	3.18	0.14	0.68	14.93
Doctor/Consultant	0.20	2.59	0.09	0.87	7.73
Technical & healthcare support	0.22	3.29	0.02	1.19	9.11
Manager	0.10	0.53	0.29	0.16	1.72
Allied Healthcare Professional	0.17	1.71	0.17	0.80	3.69
Nurse	0.22	3.41	0.00	1.73	6.74
Admin & Clerical	0.13	1.00			
Overall P-value for job role (p < 0.001)					

Figure 63 Staff reporting that they receive insufficient breaks on night shifts

There was strong evidence at the 5% significance level to reject the null hypothesis that there was no overall effect between predictor variables of job role (p<0.001) on the odds of night shift staff reporting that they receive poor breaks on night shifts. The odds of junior doctors reporting that they receive poor breaks on night shifts was between seven-and-a-half and eight times higher than staff at the administrative and clerical staff, after adjusting for the other factors. For technical and healthcare support is was around three-and-a-third times higher, and for nurses it was similarly high, after adjusting for the other factors. The graph in Figure 64 illustrates the proportions for each.

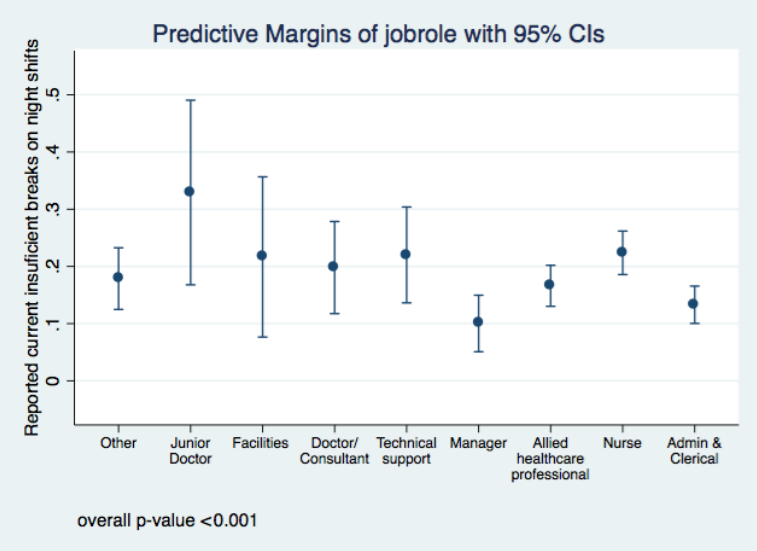


Figure 64 Graph of staff reporting insufficient breaks on night shifts by job role

The odds of night shift staff reporting a poor ideal catering situation					
	proportion	OR	P-value	(95% CI)	
shift time					
day	0.06				
night	0.56	28.39	0.00	17.54	45.96
Overall P-value for shift time (p < 0.001)					
job role					
Other (please specify)	0.10	1.02	0.97	0.40	2.62
Junior Doctor	0.22	3.97	0.02	1.23	12.82
Facilities Support Staff	0.07	0.60	0.67	0.05	6.60
Doctor/Consultant	0.14	1.83	0.27	0.62	5.37
Technical & healthcare support	0.16	2.35	0.11	0.83	6.63
Manager	0.04	0.30	0.09	0.08	1.18
Allied Healthcare Professional	0.13	1.47	0.33	0.67	3.24
Nurse	0.18	2.75	0.00	1.40	5.41
Admin & Clerical	0.10	1.00			
Overall P-value for job role (p < 0.001)					

Figure 65 The odds of night shift staff reporting a poor ideal catering situation

There was strong evidence at the 5% significance level to reject the null hypothesis that there was no overall effect between predictor variables of job role (p<0.001) on the odds of night shift staff reporting a poor ideal catering situation. The odds of junior doctors reporting that they receive poor breaks on night shifts was between seven-and-a-half and eight times higher than staff at the administrative and clerical staff, after adjusting for the other factors. For nurses, it was between two and half and three times higher after adjusting for the other factors. The graph in Figure 66 illustrates the proportions for each.

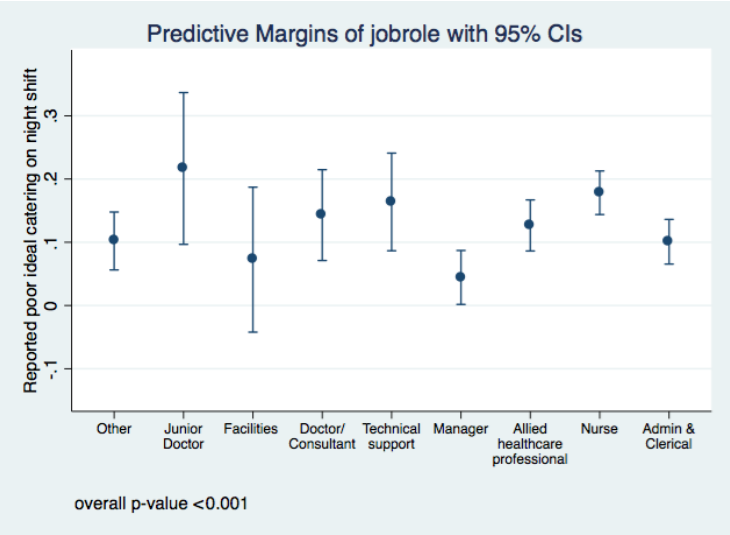


Figure 66 Graph of the odds of reporting a poor ideal catering situation by job role

Odds of getting food and drink from outside of the hospital canteen					
	proportion	OR	P-value	(95% CI)	
shift time					
day	0.09				
night	0.84	78.16	0.00	42.71	143.03
Overall P-value for job role (p < 0.001)					
job role					
Other (please specify)	0.17	1.14	0.77	0.48	2.68
Junior Doctor	0.37	6.16	0.00	2.09	18.12
Facilities Support Staff	0.21	1.87	0.41	0.42	8.44
Doctor/Consultant	0.19	1.59	0.39	0.56	4.55
Technical & healthcare support	0.18	1.34	0.59	0.46	3.86
Manager	0.12	0.49	0.16	0.18	1.34
Allied Healthcare Professional	0.17	1.15	0.70	0.58	2.27
Nurse	0.22	2.10	0.02	1.15	3.84
Admin & Clerical	0.16	1.00			
Overall P-value for job role (p = 0.01)					

Figure 67 The odds of getting food and drink from outside of the hospital canteen

There was strong evidence at the 5% significance level to reject the null hypothesis that there was no overall effect between predictor variables of job role (p<0.001) on the odds of getting food and drink from outside of the hospital canteen. The odds of junior doctors reporting getting food and drink from outside of the hospital canteen was between six and six-and-a-half times higher than staff at the administrative and clerical staff, after adjusting for the other factors. For nurses, it was between two and two and a half times higher after adjusting for the other factors. The graph Figure 68 illustrates the proportions for each.

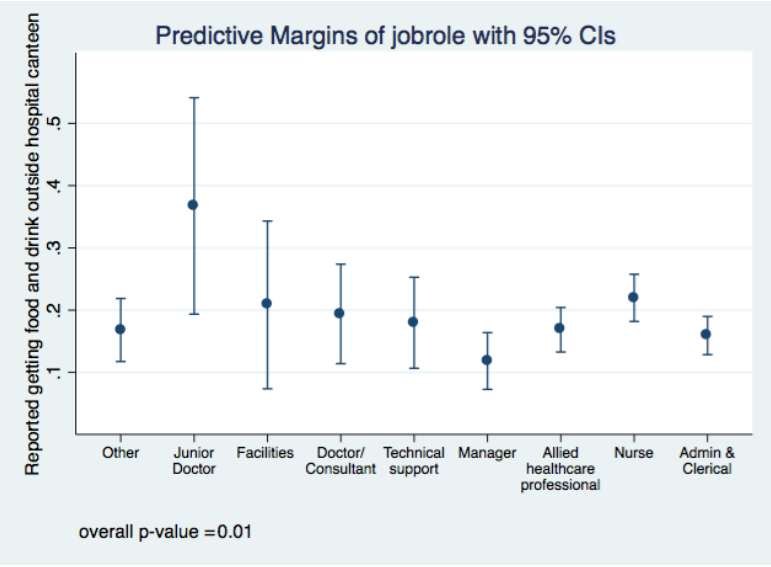


Figure 68 Graph of the odds of getting food and drink from outside of the hospital canteen by job role

This concludes the results of the staff catering survey. There is a full list of the results in Appendix F. This includes the questions not directly related. Given that the survey was a joint collaboration with public health, these questions were not directly related to the research question, but the wider issue of providing catering for staff in the Trust.

5.4 Point of sale intervention results

This section begins with the descriptive results. The null hypotheses for the point of sale interventions were:

- Any intervention would have no impact on red product sales, red drink or red food sales.
- Adding nutritional traffic light labels would have no impact on red product sales, red drink or red food sales.
- Adding a change to make water closer to eye level in the vending machine would have no impact on red product sales, red drink or red food sales.
- Adding a new product range would have no impact on red product sales, red drink or red food sales.

The outcome measures could be analysed in terms of whether the space was busy, if it was a clinical space, or if it was a staff space. This would allow service to be designed in targeted ways. For example, if the null hypothesis for label interventions was only disproved in busy locations, then with limited resource available, labelling efforts could target busy hospital areas to maximise resource. If an intervention worked universally, then it might be written in to policy or contract communication, or carried forwards for wider testing.

Descriptive results point of sale interventions

This section describes the data for the point sale interventions, starting with some overall sales levels, related to nutrition.

sum of red products for one year	85385
sum of red food for one year	66681
sum of all food for one year	136809
sum of red drink for one year	18704
sum of all drink for one year	83060

Figure 69 Sum of stock levels for the year long period across the 30 locations

To give an idea of the volume of food being sold from the vending machines in terms of nutrition, the table in Figure 70 describes the same figure shown in Figure 69 in terms of saturated fat, sugar, sodium.

annual sale break down by nutritional value			
food in kilograms	red	all	red as a % of total
saturated fat	235	293	80
sugar	784	1048	75
sodium	3	11	24
drink in litres			
saturated fat	0	23	0
sugar	3814	8367	46
sodium	4	8	47

Figure 70 Annual sale break down by nutritional value

This amount of food and drink was sold through vending machines in the 30 locations in the experiment in one year.

This is only a fraction of the overall vending across Barts Health. The volume of saturated fat (80%) and sugar (75%) is especially high in red food products, sodium is quite low (24%). For drinks, there is little saturated fat being sold, and around half the sodium and sugar sold was through sale of red drinks. This helps to illustrate the large volume of saturated fat, salt and sugar being sold from the hospital in the chosen locations and thus, the large scale of impact that vending has on people's diet. Across the NHS the volume would be amplified and the impact as well. It supports the overall premise for making improvements in vending.

Overall, the proportion of red products being sold on average from each machine was different for food, drinks and overall (Figure 71).

proportion of the sales that were red	
mean red products %	38
mean red food %	51
mean drinks %	23

Figure 71 Proportion of red products being sold as a % of the total sales

Generally, food in vending machines was split evenly into confectionary, which fell into red categories, and crisps, which favoured better and were most-often classed as green in comparison. The image in Figure 72 illustrates these 50/50 divides of food product.

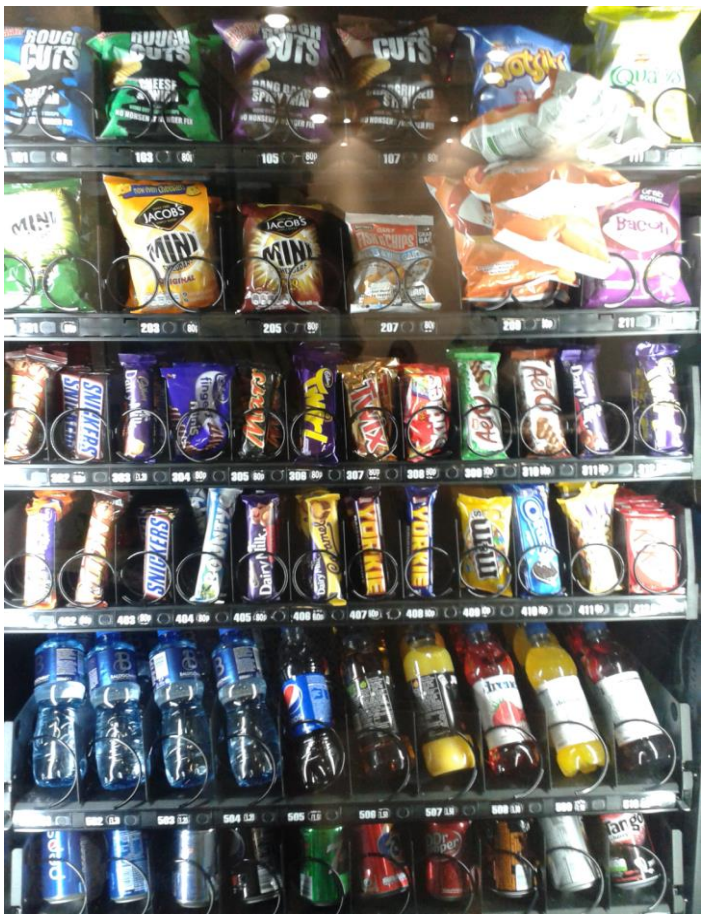


Figure 72 Image of vending machine frontage

With drinks, the number of diet drinks being sold, combined with the sale of water increased the proportion of green and amber drinks typically displayed in any vending machine. This means the available number of red products was likely to be lower for drinks at any time, and so the overall change would be lower too.

The summary of stock levels by location shows which were busiest, and which were selling the highest % of red, as well as the amount of water being sold (Figure 73).

summary of stock in actual values	sum	Intervention
A&E (RLH)	52035	Yes
Bridge Outside Restaurant L5 (RLH)	23130	Yes
Level 4 Theatres Rest Room (RLH)	13048	Yes
L3 (RLH)	10912	Yes
L12 (RLH)	9741	Yes
L9 Renal (RLH)	9639	Yes
Physiotherapy Reception L7 (RLH)	7619	Yes
Children's Day-care L6 (RLH)	7489	Yes
L11 (RLH)	7113	Yes
Pathology Reception (RLH)	7088	No
L8 (RLH)	7048	Yes
L8 (RLH)	6569	Yes
L13 (RLH)	6126	Yes
Fracture Clinic L2 (RLH)	5941	Yes
Theatres Staff Room L1 (St Barts)	5706	Yes
Total	219869	

Figure 73 Summary of top selling half of locations with stock in actual values

The A&E department is more than twice as busy as the next location on the list. The quietest locations were largely in pathology, where no interventions were installed.

The table in Figure 74 shows the % of red products sold in each location, giving only the mean and median, as the totals would not reflect any meaningful value.

summary of red stock in %	mean	median	Intervention
Queen Elizabeth 2 (St Barts)	55	55	No
Bridge Outside Restaurant L5 (RLH)	48	49	Yes
Children's Day-care L6 (RLH)	52	49	Yes
John Harrison House (RLH)	49	49	No
Theatres Staff Room L1 (St Barts)	49	49	No
Pathology L3 Floor	48	48	No
Pathology Level 4	48	48	No
Staff Room Basement (RLH)	45	46	Yes
Fracture Clinic L2 (RLH)	44	46	Yes
Central Discharge/Admissions (RLH)	46	45	Yes
Relatives Room (RLH)	45	44	Yes
L3 (RLH)	44	43	Yes
Physiotherapy Reception L7 (RLH)	43	43	Yes
Old Circulation Clinic L2	41	43	Yes
Pathology Level 2 (RLH)	42	42	No
RLH University Hospital = RLH and Floor Level = L			

Figure 74 Summary of top selling half of locations with stock in % of red products

This shows that the highest % of red stock of the total is the staff accommodation block in the Queen Elizabeth 2 building at St Bartholomew's (55%). Other notably high proportions of red sales are in the children's day-care centre, John Harrison House, another main staff-only building with several floors of support staff, and the staff only operating theatres staff room. Over half of the top ten highest proportion of red stock selling machines are in staff areas, with one being in a children's area.

Given that A&E is more than twice as busy as any other location, changing eating behaviours here would be most beneficial. As with night shift staff, there are no other retail options available for those visiting the department out-of-hours, and so, with long wait times that cross over meal times, people are likely to be using the vending machines as a source of sustenance. The overall sale of red products was relatively low in A&E, and it was in the bottom ten locations for the proportion of red products sold.

The number of machines with product range interventions (7%) and with label interventions (16%) is considerably less than a third, this will have to be considered in the interpretation of the analysis of inferential statistics.

The following tables (Figures 74, 75, 76) show the change in % of red products sold before during and after the intervention period as well as in binary form for with or without each specific intervention.

all products	mean	median
Before any intervention	42	42
During any intervention	36	39
Post any intervention	39	43
No labels	39	42
With labels	37	39
No product change	41	42
Product change	13	12
No water moved	40	42
Water moved	35	39

Figure 75 Table of % all red products changing according to intervention and intervention type

Looking at the mean, all of the interventions seem to have helped reduce the number of red products sold. The median however suggests otherwise and that product range intervention is the only effective intervention.

food	mean	median
Before any intervention	53	52
During any intervention	46	52
Post any intervention	53	52
No labels	51	52
With labels	47	52
No product change	53	52
Product change	17	16
No water moved	53	52
Water moved	45	52

Figure 76 % red food changing according to intervention and intervention type

All of the interventions seem to have helped reduce the number of red food sold looking at the mean. The median suggests mixed results. The labelling intervention performed poorly for example.

drink	mean	median
Before any intervention	25	26
During any intervention	20	24
Post any intervention	23	23
No labels	22	24
With labels	21	24
No product change	24	24
Product change	6	5
No water moved	23	24
Water moved	20	22

Figure 77 % red drink changing according to intervention and intervention type

All of the interventions seem to have helped reduce the number of red drinks sold.

The descriptive results show changes between the intervention and no intervention periods. It is, however, difficult to see if the changes were caused by which intervention, as they all occurred in overlapping time periods. One change of red product sales might be caused by one of the interventions and not the other, but be impacting the change in both descriptive tables.

The descriptive tables also necessitate that the 'no intervention period' includes both before and after period, which makes it impossible to see if either is distinctively different from one another. These matters will be addressed in the linear regression analysis.

5.5 Inferential statistics for point of sale intervention analysis

This section shows the results for the point of sale intervention analysis, including mixed-effects model results, plus the individual sign test results.

Having checked for normality of distribution using the Shaprio-Wilk tests, 8 out of a possible 30 tests made it possible to reject the null hypothesis and gave a P-value under 0.05. This meant

that the null hypothesis could not be rejected in most cases. The table shows the significant findings from the paired t-test results on point of sale analysis. In order to keep tests consistent and allow for comparison, the same paired t-test was used on all data at this stage in the analysis. The results of the normality test also meant that a transformation of the data for the mixed-effects portion of analysis would not be necessary.

Significant sign test results	Mean (range) base	Mean (range) trial	Mean (range) post	Any vs Before Intervention P-value	95% confidence interval	
All Red products for any interventions	42.37	37.13	39.91	0.0235	-9.68	-0.79
All Red products for label interventions	42.37	37.13	42.80	0.0235	-9.68	-0.79
All Red products for product range interventions	37.92	12.62		0.0129	-37.80	-12.80
All Red products for water	42.13	35.11		0.0304	-13.26	-0.78
Red food for product range interventions	53.89	16.66		0.0253	-63.21	-11.25

Figure 78 T-test results for all red products for point of sale intervention

The impact of any intervention vs label interventions was the same or almost the same looking at all red products, red food and red drinks. This is because where a label interventions were installed in all the intervention locations, so saying any intervention is almost the same as saying label intervention. The only difference was in the small sample of machines where product intervention and water interventions remained after the intervention period and given that none of those instances yielded significant P-values, they can be discounted.

This results table in Figure 79 shows several variables that helped reduce the % sale of red products. Since the first P-value is small (0.0235) it shows that in combination, the interventions had a positive impact, reducing the sale of red products by 5% when comparing the intervention to before intervention period. The confidence interval is, however, close to crossing the no effect threshold of 0.

Product range interventions had a much more positive impact on reducing red product sales than any intervention. A P-value (0.0129) shows that the product range interventions reduced the sale of red products by 25% when comparing the intervention to before intervention period. The P-value for the impact of product range intervention on red food sales was also small (0.0235), showing that in combination, the interventions had a positive impact, reducing the sale of red food by 37% when comparing the intervention to before intervention period.

A P-value (0.0304) shows that the water placement interventions reduced the sale of red products by 7% when comparing the intervention to before intervention period. The confidence interval is, however, close to crossing the no effect threshold of 0.

Significant sign test results	Mean base	Mean trial	Mean post	Any vs Before Int P-value	95% confidence interval		Before vs after Int P-value	95% confidence interval	
Red drinks any int	25.29	20.48	21.92	0.0007	-7.30	-2.31	0.047	0.15	15.29
Red drinks label int	25.29	20.48	19.59	0.0007	-7.30	-2.31	0.047	0.15	15.29
Red drinks water int	24.42	20.00		0.0027	-7.01	-1.84			

Figure 79 T-test results for red drink for point of sale intervention

The impact of any intervention vs label interventions was, as with red food and all red products, the same or almost the same. Red drinks sales were impacted differently from red food sales.

The third P-value (<0.001) shows that the combination of interventions had a highly significant positive impact, reducing the sale of red drinks by 5% when comparing the intervention to before intervention period. The confidence interval is, however, close to crossing the no effect threshold of 0. There is also a significant, although only just significant, 4% decrease in the % of red drink sales between the before and after periods caused by any interventions (P-value 0.047). The confidence interval is, however, close to crossing the no effect threshold of 0. Water interventions also created a significant 4% decrease in the sale of red drinks with a P-value of 0.0027. The product range interventions did not have a significant impact on red drinks sales.

These results are given before adjusting for other factors. Using this method, red food and drink, as well as overall sales, showed a significant change resulting from the interventions.

Inferential results linear regression

The results given after adjusting for other factors altered the findings when compared to the sign test results above. The mixed modelling approach revealing a more dynamic relationship between the exposure, conditional and outcome variables. The condition of spaces where the vending machines were situated, if it was busy or quiet, clinical or non-clinical, staff or public, were all considered as potential impactors on the outcome variable. In choosing these conditional variables, there was an issue with collinearity in the results in the mixed model. As a result, it was not possible to report the statistics for if the conditions of the vending location were public or private.

The combined variables interventions split by time periods of before, during and after intervention of water placement, intervention of labelling, intervention of product range, the condition of clinical space, staff space and busy locations were all present in the model. The time periods of before and during, during and after, and before and after were compared, as well as an overall comparison between all three for any intervention.

Analysis of % of all red products sales					
Comparing all three time periods as a whole for all products					
	proportion	Coefficient	P-value	(95% CI)	
Before intervention	41.82	0.00			
Intervention	36.59	-5.23	0.008	-9.10	-1.37
After intervention	39.76	-2.07	0.489	-7.91	3.78
Comparing all product sales for baseline and intervention periods					
Intervention product range					
0	41.61	0.00			
1	16.77	-24.84	0	-29.31	-20.37
clinical space					
0	44.63	0.00			
1	38.89	-5.74	0.03	-10.90	-0.57
adjusted for intervention types all products times 2&3					
Intervention product range					
0	40.46	0.00			
1	12.70	-27.76	0	-39.83	-15.70

Figure 80 Mixed-effects analysis of % of all red products sales

The sale all red products, as a percentage of the total sales, reduced by 5.23% during the intervention period compared to the before intervention period, adjusting for the other factors (Figure 80).

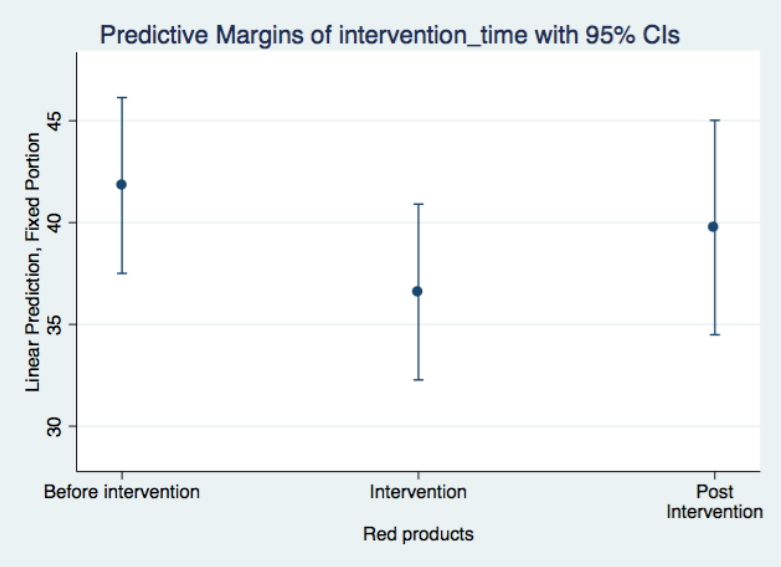


Figure 81 Graph of sale of % of all red products by time period

Including only the before and during intervention time periods in the analysis, the sale of red products reduced by approximately a quarter in machines where products were changed for the healthier product range compared to those that weren't changed, adjusting for the other factors (Figure 81).

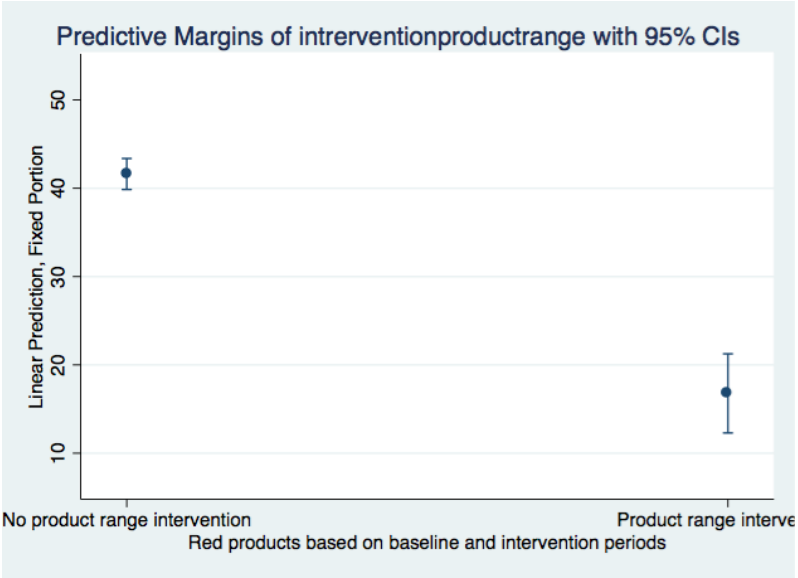


Figure 82 Graph of sale of % of all red products by time period comparing intervention of product range

In the same comparison period of before and during, the sale of red products was 5.74% lower in machines located in clinical spaces, compared to non-clinical spaces, adjusting for the other factors (Figure 83).

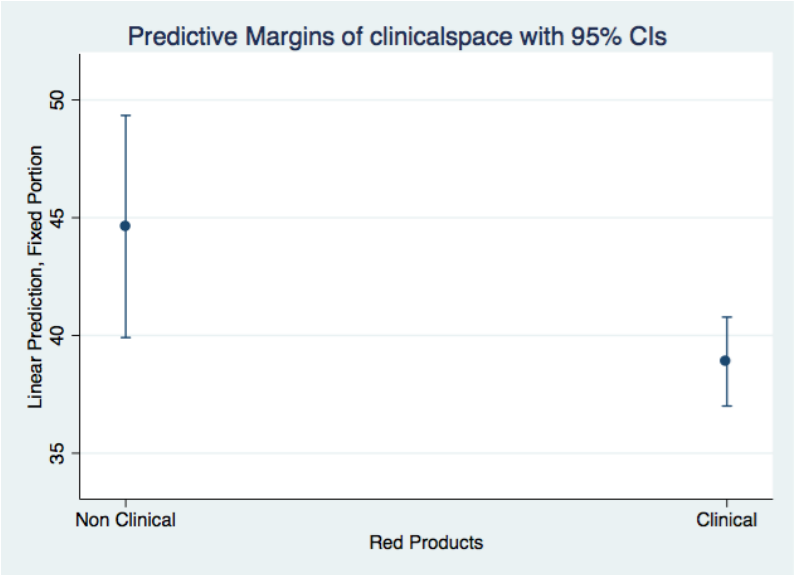


Figure 83 Graph of sale of % of all red products before and during, comparing clinical spaces

Including only the during and after intervention time periods in the analysis, the sale of red products reduced by a similarly large amount as when comparing the before and during time periods. Red product sales reduced by over quarter, 27.76%, in machines where products were changed for the healthier product range compared to those that weren't changed, adjusting for the other factors.

Analysis of % of red food sales					
Comparing sales of food products for all three time periods					
	proportion	Coefficient	P-value	(95% CI)	
Before Intervention	53.01	0.00			
Intervention	46.58	-6.42	0.025	-12.05	-0.80
After intervention	53.24	0.24	0.950	-7.09	7.56
Comparing sales of food products during baseline and intervention periods					
Intervention product range					
0	52.56	0.00			
1	16.87	-35.69	0.000	-42.42	-28.96
Comparing sales of food products for intervention and post intervention periods					
Intervention labels					
0	50.72	0.00			
1	48.27	-2.45	0.025	-4.60	-0.30
Intervention product range					
0	52.40	0.00			
1	17.58	-34.82	0.000	-41.61	-28.04
clinical space					
0	53.88	0.00			
1	48.20	-5.67	0.034	-10.92	-0.43
	Comparing sales of food products during baseline and post-intervention periods				
location busy					
0	50.94	0.00			
1	55.76	4.82	0.048	0.04	9.60

Figure 84 Mixed-effects analysis of % of red food sales

The sale of red food, as a percentage of the total sales, reduced by 6.42% during the intervention period compared to the before intervention period, adjusting for the other factors. These results have similarly wide confidence intervals as with all red products, representing variability in the data (Figure 84 visually represented in Figure 85).

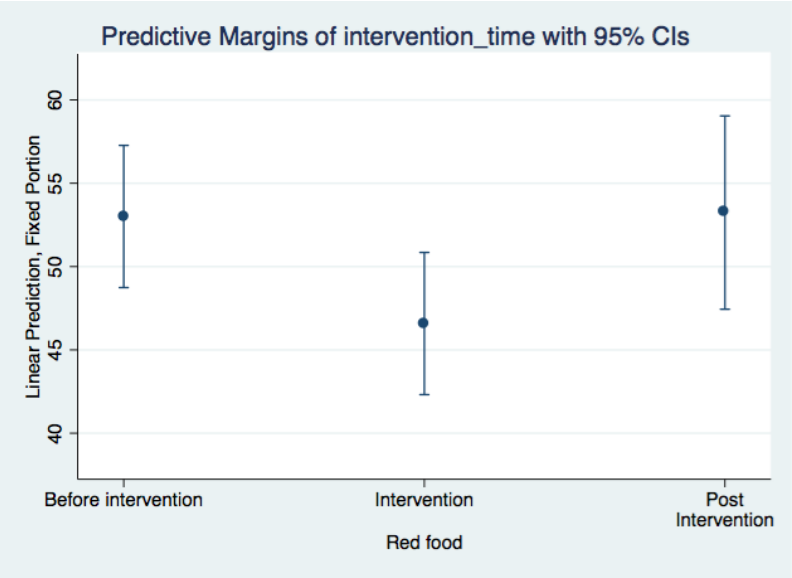


Figure 85 Graph of sale of % of red food by time period

Including only the before and during intervention time periods in the analysis, the sale of red foods reduced by 35.69% in machines where products were changed for the healthier product range compared to those that weren't changed, adjusting for the other factors (Figure 86).

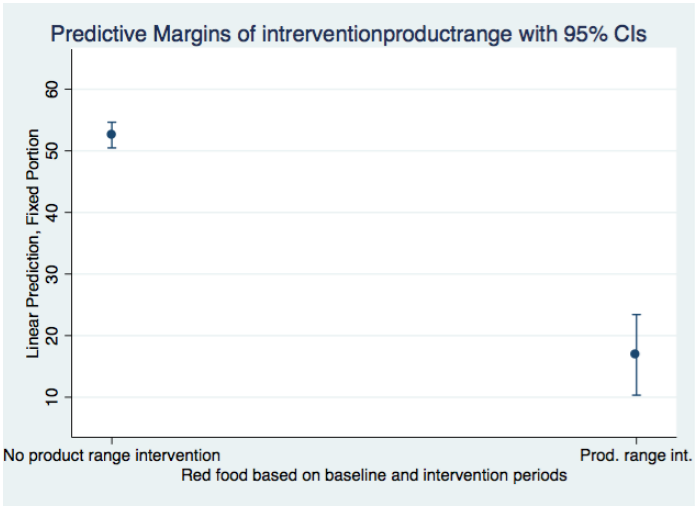


Figure 86 Graph of sale of % of red food by time period comparing intervention of product range

The analysis revealed similarly dramatic impact when including only the during and after intervention time periods in the analysis. The sale of red food decreased by around 35% in machines where product range was changed compared to those that weren't changed, adjusting for the other factors.

Including only the during and after intervention time periods in the analysis, the sale of red food decreased by approximately 2.5% in machines where traffic light labels were installed compared to those that weren't changed, adjusting for the other factors. This was a small but significant change (Figure 87).

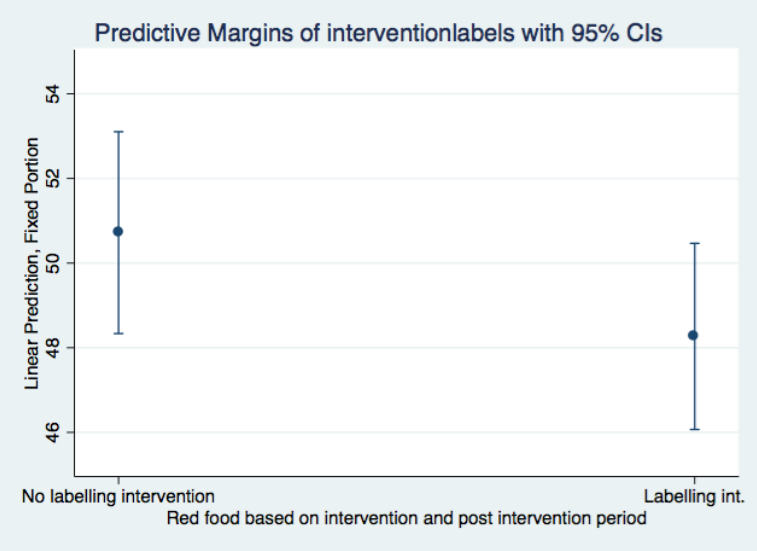


Figure 87 Graph of % of sale of red food during and after comparing intervention of product labels

Including only the during and after intervention time periods in the analysis, the sale of red food decreased by approximately 5.67% in machines located in clinical spaces compared to those that weren't, adjusting for the other factors. This was similar to the impact that clinical spaces had on sale of all red products.

Finally, for analysis of food sales, including only the before and after intervention time periods in the analysis, the sale of red food as a percentage of the total sales increased by nearly 5% in machines located in busy spaces compared to those that were not, adjusting for the other factors (Figure 88).

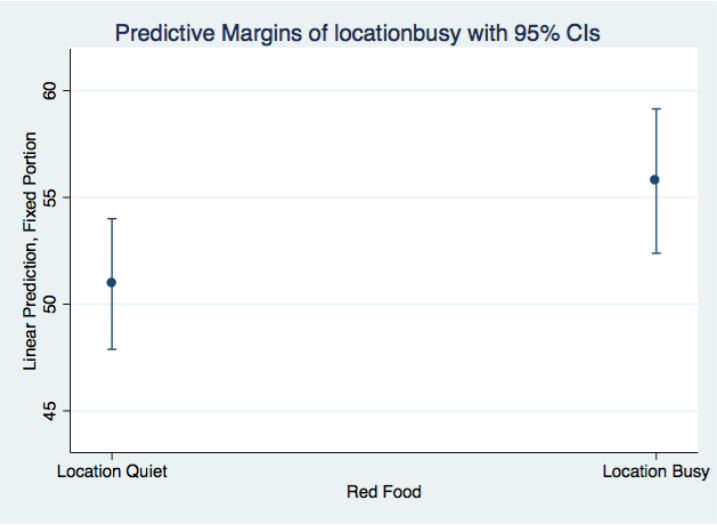


Figure 88 Graph of % of sale of red food during before and after periods comparing busy and quiet locations

Analysis of % of red drink stock levels					
Comparing stock levels of drink products during all three time periods					
	proportion	OR	P-value	(95% CI)	
Before intervention	25.93	0.00			
Intervention	21.12	-4.81	0.000	-7.13	-2.49
After intervention	19.42	-6.51	0.000	-10.14	-2.88
Comparing stock levels of drinks during baseline and intervention periods					

intervention labels					
0	25.38	0.00			
1	20.39	-4.99	0.005	-8.46	-1.53
intervention product range					
0	23.66	0.00			
1	13.28	-10.38	0.000	-15.78	-4.98
Comparing stock levels of drinks during and post intervention periods					
intervention product range					
0	22.64	0.00			
1	5.94	-16.70	0.000	-24.71	-8.68

Figure 89 Mixed-effects analysis of % of red drinks sales

The sale red drinks, as a percentage of the total sales, reduced by 4.81% during the intervention period compared to the before intervention period, adjusting for the other factors. It was also 6.51% lower in the post intervention period when compared to the before intervention period, adjusting for the other factors (Figure 90).

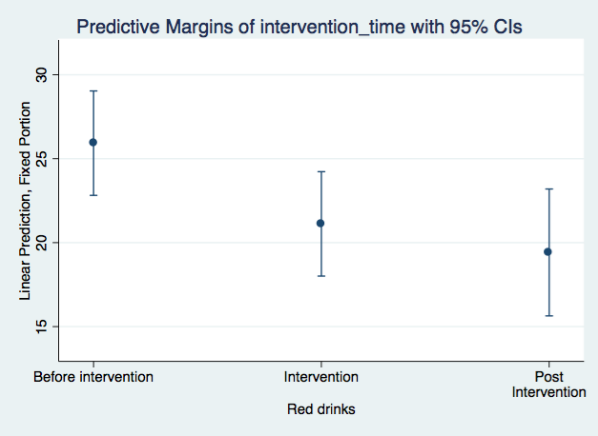


Figure 90 Graph of sale of % of red drinks by time

Including only the before and during intervention time periods in the analysis, the sale of red drinks decreased by approximately 5% in machines where traffic light labels were installed compared to those that weren't changed, adjusting for the other factors (Figure 91).

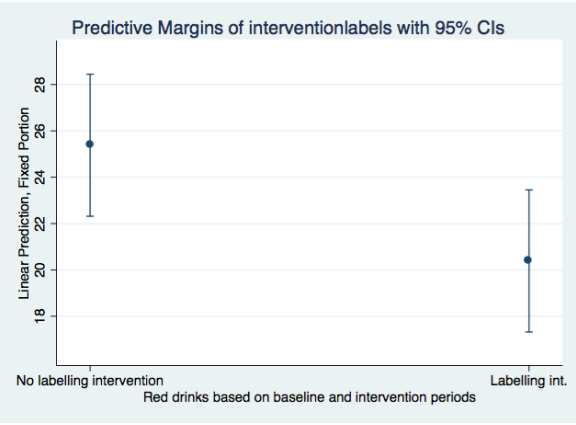


Figure 90 Graph of sale of % of red food during and after comparing intervention of product labels

Similar to the change observed for food sales in the during and after intervention periods, the confidence interval range is wide, suggesting variability in the data.

Including only the before and during intervention time periods in the analysis, the sale of red drinks reduced by just over 10% in machines where products were changed for the healthier product range compared to those that weren't changed, adjusting for the other factors (Figure 91). This is a large percentage considering that the mean sale of red drinks for all machines for the entire year was 23%, reported earlier (Figure 71).

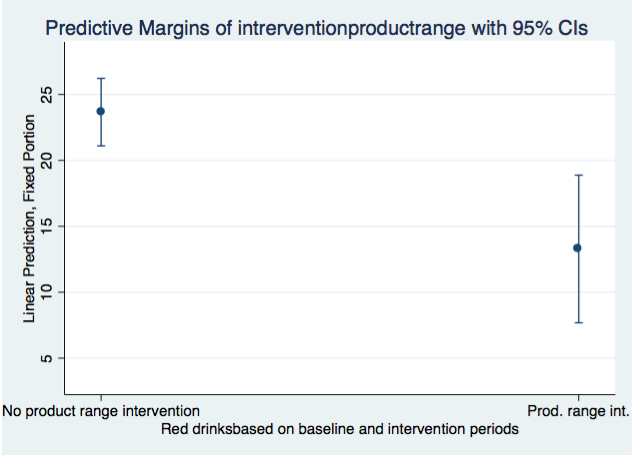


Figure 91 Graph of sale of % of red food by time period comparing intervention of product range

Including only the during and post intervention time periods in the analysis, the sale of red drinks reduced by just over 16% in machines where products were changed for the healthier product range compared to those that weren't changed, adjusting for the other factors. This is again a large percentage considering that the mean sale of red drinks for all machines for the entire year was 23%, reported earlier (Figure 71).

5.6 Conclusion

This chapter has set forth the significant results of the two primary pieces of research, the point of sale experiment and the staff survey. Relating the results back to the hypotheses:

- In the point of sale experiment the null hypothesis was disproved and the interventions as a whole had a significant impact on reducing the red product sales (Figure 80), red drink (Figure 89) and red food (Figure 84) sales.

- Adding nutritional traffic light labels had a significant impact on red food (Figure 84) and drink (Figure 89) sales but not on the total sales and the food sales results were very close to crossing the effect threshold of 0 (Figure 84).

- Adding a change to make water closer to eye level in the vending machine had no significant impact on red products, food or drink sales. This may have been due to a small sample size.

- Adding a new product range had a significant impact in all instances and was by far the most successful intervention (Figure 80/84/89).

- Clinical spaces and busy spaces showed that they reacted slightly differently to the interventions too (Figure 80/84/89).

- In the survey, staff at the Royal London, Newham and night soft staff had a significantly worse opinion of vending including vending drinks compared to the baseline (Figure 49/51).

- Staff who reported using vending more than a few times a month were significantly higher among night shift staff, technical & healthcare support and nurses compared to the baseline (Figure 53).

- Staff, especially those at St Bartholomew's, the Royal London, nurses, facilities support staff and managers were significantly more likely to report spending more than £4 a day on food and drink than the baseline (Figure 56).

- Staff were more likely to perceive vending costs as high if working night shifts, or at Newham or Whipps Cross, compared to the baseline (Figure 59).

- Night shift staff, junior doctors and nurses were significantly more likely to report that they received insufficient nutrition on shift compared to the baseline (Figure 62).

- Night shift staff, technical & healthcare support, junior doctors and nurses all had a significantly higher chance of reporting that they receive insufficient breaks compared to the baseline (Figure 63).

- Night shift staff, junior Doctors and nurses had a significantly high chance of reporting an insufficient ideal catering situation (Figure 65).

- Night shift staff, junior doctors and nurses were significantly more likely to report that they get food and drink from outside of the hospital canteen more than a few times a month compared to the baseline (Figure 67).

These findings will be discussed further in the next chapter.

Chapter 6. Discussion and Conclusions

6.1 Introduction to discussion of survey results

This research surveyed a key population of vending service users, in this case focusing on staff. The survey was an exploratory piece of work, to baseline staff opinion of the service and find areas for targeted service improvement. The exercise of conducting and formally analysing the staff catering survey could itself be viewed as a benchmark, creating a standardised method of conducting and analysing end service user opinions in NHS catering. The survey was also timely, as there is currently very little understanding about the role of vending in healthcare, and its relation to staff health and well-being especially in a night shift scenario.

The survey results showed an overall negative opinion towards vending, especially at the Royal London and Newham University hospital (see Figure 49 and Figure 51). Compared to the locations in the point of sale study, the survey was able to include all the lcoations in Barts Health NHS Trust, not just the Royal London and St Bartholomew's. These two locations have recently been the focus of vending improvement initiatives, suggesting that the increased attention and changes to service may have highlighted dissatisfaction among staff in those locations. Regardless of speculation, the levels of dissatisfaction are helpful indicators of where changes might begin if the service were to be improved. Another key area where improvements should be focused was revealed to be for night shift staff. There was strong evidence that their opinion of vending services was significantly lower than day shift staff (see Figure 49 and Figure 51). The survey also revealed that night shift staff were using vending significantly more than day shift staff (see Figure 53).

Health

The survey was part of a larger effort to improve catering at Barts Health and across the NHS. Improving staff catering is especially vital. It has previously been estimated the NHS could reduce its overall sickness rate by a third – the equivalent of adding almost 15,000 staff and 3.3 million working days at a cost saving of £550m, by improving the health and well-being of staff (NHS England 2014, Marmot 2010, DoH 2014, Barts 2016, Kibblewhite et al 2010, Norton 2014). The same policy focus on improving staff diets for overall well-being has been linked with the overall efficiency of the NHS, clinical care, stronger financial performance and lower levels of patient mortality (West and Dawson 2012 in Kings Fund 2015, Marmot 2010, NHS England 2014).

As well as linking with an overall drive for better catering, healthier behaviour is being incentivised and supported by the NHS, in the context of preventative measures, particularly targeting issues such as smoking, alcohol consumption and poor diets in healthcare, and encouraging staff lifestyle improvements internally (NHS 2016, Marmot 2010; NHS England 2016 b İnce Güney 2014). Staff and non-patient catering service improvement plans overlap with preventative models of healthcare, initiatives to link with the community, health education, and supporting staff, patients and stakeholders in healthcare facilities to make the 'right' choices (WHO 2015, Nice 2016, FFLP 2016, Nice 2015, NHS England 2014, NHS England 2016, Maruthappu 2016 HPH 2015, NHS 2016, NHS England 2016 b.).

Amid increasing policy to govern catering services in the NHS and drive towards staff health and well-being and preventative models of care and healthy lifestyle choice, there has been scrutiny over how vending machines fit into a public health message and strategic vision for catering in the NHS (HFSP 2014). The role of vending as an enabler in making poor lifestyle decisions has

been linked through various research to agendas such as work performance and public health. This research highlights the importance of vending as an enabling factor of poor lifestyle choices amid people who are a captive audience, and/or those working long, unsociable hours (Kelly et al 2012, Apostolopoulos et al 2011, Escoto et al 2010).

This survey focused on staff working unsociable hours and the link to vending. It is the sole retail outlet for staff working night shifts and for significant periods of operational time and sells some of the least nutritious products available on the retail catering market.

The explicit link between vending and night shift staff can be seen at Barts Health as the catering contract at the time of this research stipulated that the catering service provider would ensure out-of-hours catering for staff, and this was being achieved through vending. This solution to night shift catering is at odds with the NHS drive for sustainable care and long-term health. Improving vending is mainly for the benefit of staff when considered at a contractual level. A large issue such as preventable care and staff health and well-being, can be directly related to vending services as a result. It is common in the NHS for night shift staff to experience similar problems with catering. Three quarters of hospitals in the NHS do not offer healthy food to staff working night shifts (NHS England 2014).

The results of the survey confirmed this as 62% of night shift staff reported that they received insufficient nutrition on shift (Figure 35). The problem in the findings of the survey were that, as well as not currently receiving sufficient nutrition on night shift, staff had an ideal that was also below the acceptable level of catering for them to remain nourished whilst working. 66% of night shift staff reported an ideal catering situation that was inadequate (Figure 36). In this instance, it suggests that an educational requirement exists with night shift staff. Referring back to the Marmot 2010 report for Barts Health, communication is an excellent area from which to draw solutions from as it cuts across every aspect of services and Barts Health should adopt communication to improve staff health and well-being through catering (Marmot 2010). An education strategy for healthy lifestyles for night shift staff based around communication and learning would be of benefit.

While there is existing guidance on how to improve staff health and well-being, this survey allowed one to link it with vending services. The advice issued to NHS Trusts to cut access to unhealthy products on NHS premises, implement food standards, and provide healthy options for night staff for improved staff health and well-being must to be followed by tangible changes (NHS England 2014).

Another key area of the survey was the revelation that staff were receiving poor breaks on night shifts, not enough breaks being taken in unsuitable spaces and consuming innutritious food and drink. This could be remedied with stronger messages to managers to ensure staff are taking breaks and taking them off the ward in order to refresh and relax away from the work environment. The most startling figure of the survey was that 84% of night shift staff currently receive insufficient breaks. This is a critical area to target in the event of improving the overall health and well-being of night shift staff.

Out-of-hours catering for staff and vending services is a good example of a service area that is standardised with non-routine and non-core elements of catering and healthcare services that do not fit with the regular day time approach to management. It requires strategic vision to foster improvement, but one that aligns with the entire catering service as a whole. The development of a food and drink strategy at Barts Health for example must consider the flexibility required to meet the non-standardised aspects of the service such as night shift working. It is not sufficient to say to provide healthy food for all staff, it must be clear that extra consideration and resource will be required to develop night shift meals as they are currently

underprovided for. Making changes such as targeted improvements to break taking and continuously engaging night shift staff in their health and well-being would be an ideal goal for any strategic vision.

There was concern at Barts Health before the survey that staff had little time to take proper breaks and were especially dissatisfied with the choices available out-of-hours. This has been proven to be true via the staff survey.

Service upsell

There were several aspects of the survey that would help leverage change in service in commercially attractive ways. These would help in-house FMs at Barts Health who were looking for ways to improve automated automated food and drink vending services and meet public health agendas for healthier retail catering for all. The utilitarian stance is to ultimately contributing to the goal of staff well-being. However, there is a strong need for cost saving or commercially attractive service changes to meet cost improvement targets, but also to show potential revenue streams.

An early indicator that there may be a missed retail opportunity was when staff could often be seen carrying takeaway boxes into hospital during out-of-hours periods. This suggested that vending is not sufficient for their dietary needs (as one would expect), and that this gap in the market was creating an unhealthy eating culture among night shift staff. The lack of adequate onsite provision is not only unhealthy; it is also taking potential retail catering business away from Barts Health.

In terms of potential revenue, nurses, facilities and management staff were those strongly linked to spending the most on food and drink (see figure 56). As would be expected, central hospitals were the sites where staff were spending the most (see figure 56). This reveals where the most money is being spent by staff, and potential groups and sites to target more diverse catering options. 58% of night shift staff also spent £4 or more on average per day on food and drink, showing that they too might be potential customers for a new catering service aimed at upselling and profit increases (see Figure 42). 71% get food elsewhere than the hospital canteen (see figure 41). This indicates that there is a potential opportunity to create a night shift catering option, as most staff go elsewhere currently.

Another aside to consider is that the fridges and microwaves provided in staff rooms require regular maintenance and cleaning which would be less of a burden if staff were using retail outlets onsite instead of bringing food from home. If the entire service was kept under one service structure, the cleaning of staff rooms and catering facilities might be scheduled simultaneously to pool resources. In reality, it is likely that a restrictive contractual structure, one of cleaning and one for catering, would prevent this kind of innovative resource sharing.

The tangible impact of the survey

This researcher tested and developed guidance at the end service user end, given that little tangible advice is given on actual improvement initiatives that have been evidenced through primary research, and little was understood about the end service users of staff at Barts Health for catering. The results of the staff survey, conducted through this research, were used directly in the strategy document for food and drink services, as well as the results of the work done to evaluate the DEFRA GBS as part of the working group. Using end service user feedback was vital to evidence that the Trust's vision was supported by staff, and that it listened to their needs.

This section has identified several specific areas such as improving night shift breaks which could also be more strongly argued for incorporation into service design at the FM-end of catering in Barts Health and the wider NHS. Targeted retail opportunities may exist for night shift catering and these could be timed in alignment with staff break times.

6.2 Discussion of point of sale interventions

This research set out to evaluate how communication technologies can deliver public health agendas in National Health Service food and drink automated vending. This experiment trialled nutritional labelling, product placement of water and product range changes, each of which are a communication based design at the point of sale. It also considered whether the location of the vending machines, whether they were situated in a clinical space or in a staff space, made an impact on the trials.

The research focused on where scientific knowledge can be grouped and applied to improve communication within NHS FM vending services towards public health policy. As a result, new knowledge was generated. The group of knowledge generated by the point of sale interventions was based on communication and service design and can inform areas of policy, strategy, supply chain, service contracting, point of sale, and end service user engagement.

The experiment pinpointed vending machine point of sale as a key area where the government has identified that NHS trusts such as Barts Health can and should improve service towards public health outcomes (HFSP 2014, NHS England 2014, WHO 2015, DoH 2014, Marmot 2010). Understanding how the current knowledge can meet these goals and improve vending in healthcare was an unknown quantity prior to this research. Therefore, the results of the several variables that were tested at the point of sale can now inform a more detailed description of how hospital Trusts in the NHS can improve their vending services and meet government goals

The main findings that could be used as the basis for further discussion are highlighted below. The summary statistics for the vending sales are useful communication tools in getting attention from the board for permission for changes in service. Models of communication rely on conceptual structures of abstractions and modes of representation in order to create meaning between people that can lead to action (Licklider 1960, Cohen and Bailey 1997, Coakley et al, Erb et al 2009). The message must be easy to understand where audiences operate on a national population level. This was discussed in section 2.7 Aesthetics: Aesthetics and communication tools at the point of sale.

In these results of the point of sale experiment, the amount of sugar sold out of vending machines in one year at one of the Barts Health sites is as heavy as a man in a white van. Using the example of a man in a white van is meant to be memorable and engage people's imaginations and white vans are an everyday site that people can relate to. Finding memorable ways to engage people in the need for service change is crucial, especially when delivering messages at board level, where background knowledge is limited and attention likely to be brief. A strong focus on communication ensures that messages are tailored to the correct audiences.

According to the results of the paired t-tests, several of the interventions had a favourable impact on the reduced % of red food being sold. Red products are those scoring least healthy according to the across the board nutritional profile used. Labels positively impacted the sale of red food and drink although the confidence interval for red food sales was close to crossing the no effect boundary of 0 (figure 78 and 79). Product range interventions strongly and positively impacts the % of red food sales (figure 78). The product range interventions did not

significantly impact the % of red drink sales (figure 79). Finally, water interventions significantly reduced red product sales by 4% (P-value 0.0027).

This shows that water interventions were effective for reducing the number of red drinks sold and there was an overall positive relationship between the reduced sale of red products and the interventions.

Based on the results of the mixed-effects modelling, the interventions as a whole had an impact on reducing the amount of red products being sold by just over 5%. Product range changes impacted red product sales most strongly. Given that a higher proportion of the food being sold in vending machines was classified as red, there were more dramatic reductions to be made in the amount of red food products than for drinks. For example, comparing the before and during time periods, red food sales decreased 25.31% more than red drink sales.

Clinical areas sold significantly less red products when comparing before to during intervention periods, although this trend did not hold for red drinks. There was a significant reduction in the sale of red drinks by 5% created by the introduction of traffic light labels, comparing before and during intervention time periods, although there was a wide confidence interval for this result suggesting variability in the success of using traffic light labels.

The water interventions might have made an impact, especially given the significance of the findings using the t-tests. This was not carried over in the regression analysis and so, given the conflicting results, more testing using a larger sample may be required to confirm if the water intervention did or did not have an impact. The results suggest that a larger sample size would confirm that moving products to eye level does have a positive impact on encouraging sales. Water placement changes were also further potentially limited due to the make of the vending machines. It was only possible to move the water in most machines part way to eye level.

Policy guidance advises, among other initiatives, that at point of sale clear information and labelling and use of traffic light food labels in vending machine services might aid service improvement (HFSP 2014, NHS England 2014, WHO 2015, HFSP 2014, DoH 2014, Marmot 2010). The results of this experiment show that using the across-the-board nutritional profile, traffic light labelling does have a positive impact and is a viable method by which Trusts can achieve clear and informative labelling.

Wider implications of the point of sale interventions

As well as evaluating the kinds of labelling techniques that one might wish to employ, this research also viewed the matter as an essentially context-driven research problem, focusing on the broader goals of encouraging healthier choices in the context of different communication. Introducing the nutritional profile is a way to create a shared foundation that can be written explicitly into policy guidance such as the DEFRA balanced scorecard, the SRA catering audit questions, the soft FM tender, and communication with end service users. This forms a solid foundation from which to have tangible discussion over service change.

The Rayner model is ideal as it has already been used successfully in public health campaigns by the World Health Organisation, in countries such as in Australia and France, as well as in small scale informal studies such as the NHS Wales vending project (ANSES 2015, Jewell 2008, Sloane 2014, Bolton NHS Foundation Trust 2010, Rayner 2014, Rayner 2013). All report favourably on the profile. However, none have produced an experiment that tests it as a vehicle for point of sale vending labels, and not in healthcare. This means that the profile is well suited to this research problem, but remains untested, and therefore the research makes a novel contribution to the development of the application of the profile.

Applying the model to create traffic light labels is a low-cost way to make a positive change in vending. Fixing product lists with the colour coded labels on them in vending stock rooms would make it possible for stockists to check where they place products.

There are also many wider methods associated with the design of the point of sale environment and influencing user and customers. Some locations, such as A&E require slightly different product ranges given that the sales show people prefer non-red products, and purchase large volumes of water. A dedicated water vending machine, plus a focus on more substantial products such as milk-based drinks, confectionary with grains inside such as biscuits and flapjacks, would, this research predicts, be commercially successful products to trial in A&E. They are also better scoring on the nutritional profile, creating a 'win-win' situation.

One of the most significant barriers to improving vending towards public health is the costs. It is a short calculation to see how much revenue the machine made. The overall sales in the machines tested was 85,385 products in 12 months. The price of confectionary and savoury snacks was £1.00 each (with slight variations due to mislabelling). The price of drinks between £1.20 and £1.70 with around a quarter of the shelf space dedicated to £1.20 water making an approximate average price of drinks £1.55. Given the total sales, the revenue would be around £42,600. Given that the trial took place mostly in one hospital and a small number of locations in another, and there are five hospitals in total in the Trust, Barts Health vending might present a significant revenue opportunity. With more time and a wider research aim, a detailed analysis of the cost and revenue impact would be incorporated into the analysis.

Commissioning for Quality and Innovation (CQUIN) 4

The CQUIN 4 is important to this research. The findings from the two pieces of primary research contribute to Barts Health being able to demonstrate that it meets the funding requirements and potentially be awarded the CQUIN funding. The CQUIN 4, set up to provide funding to create improvements, is a positive tool in current NHS provision to work towards improvement. Targeting breaks and catering for night shift staff would be an ideal way to showcase efforts towards applications of the CQUIN 4. The survey provides evidence for why a strategy would be launched too and therefore this research itself is an example of the Trust's efforts to meet the standard.

Given the new policy focus on staff and retail catering, the failure to meet demand for out-of-hours catering may, in the future, become a legal and contractual ground for service improvement across the NHS.

6.3 Discussion of the nutritional profile adoption in the NHS

The research set out to reduce unhealthy vending. In chapter 2, the systems model that this researcher created was based around reducing red products, for example. One may wish to increase healthy choices, however given the limit of product types available in vending machines, the NAT group at Barts Health advised none of the products in vending machines could ethically be termed healthy. This highlights the restrictions of the context in which improvement must take place, and the nature of the products being sold. It was only ethically possible to reduce the least healthy products sold.

Finally, using the profile might, given the experience working in the NHS, be too complex and resource-consuming to apply. Churchman warns against creating confusing information, and the volume of data and disparity of measures can work against improvements (Gase et al 2011). If the nutritional profile were to be adopted, a central service would be required with lists of

products and their ratings. The model could not be applied individually by NHS Trusts or contractors themselves. Measures of public health, health care costs, policy and catering procurement allude to different data sets with varying degrees of supply chain transparency inherent. Creating a product list and enquiry service where products could be reported and centrally given a rating would negate this complexity. This is similar to the adoption of the profile in France and Australia.

Further critiquing the available guides and profiles

In the simple FSA guide for public health communication, the fat, saturated fat, sugar and salt focus in public health guidance does not account for other ingredients such as fiber, vitamins, minerals and proteins essential for a healthy diet. These kinds of nutrients have less obvious impact on public health measures such as obesity or caloric intake. Also, additives, chemical and sweeteners may have negative health impacts, yet little or no calories in them to potentially increase one's weight. With the attention on obesity, nutrition is circumvented in public health guidance.

There are also international discrepancies in measurement methods. In comparison to the UK use of grams per 100g on labels, European guides use total energy (%E) instead of grams and calories (WHO 2015, EUFIC 201). This differing approach to measurement can change in other ways as well. The measurement, terminology, adjoining research and government approaches to targeting certain nutrients regularly changes (FSA 2015, EUFIC 2015, Hoffman and Gerber 2012). These variations naturally confound standardisation of healthy products, as well as people's understanding of nutrition.

Despite the conflicts and changeability of public health guidance on nutrition, the typical products in vending machines are still frequently above the 'high' levels of fat, sugar, salt and saturated fat, according to FSA rating. There is also evidence to show that regular consumption of these nutrients, at a high level, can lead to serious and life-threatening health complications (NHS 2015, Bundrick et al 2014, Davy et al 2014, Fletcher et al 2010, Kubik et al 2012, State Government of Victoria 2015, Kristy 2014, Goldstein and Leshem 2014, Nutrition Australia 2015, Medline Plus 2015, FSA 2014, WHO 2015, CDC 2012).

The health risk of a poor diet is attached to healthcare costs. Reducing intake of ingredients, for example salt, has even been linked positively to health care spending (Gase et al. 2011). Against increased policies on diet and NHS catering, this is presents a serious problem for Trusts. They risk their reputation endorsing such products, as well as contributing to the overall landscape of the UK's unhealthy lifestyles.

It would seem that of the guidance presented, much work is needed to understand and incorporate it into service design, flawed and changeable as it is. The examples given above, in their current format, would have to be explicitly linked to service management contract performance measures, and embedded into service culture to yield results. Even still, it is not certain that the available guides will be adequate or suitable.

Reflection on the role of portion size in future work

Portion size was not factored into the experiment, as it has not been proven to be a successful method of influencing choice. The literature review by Skov et al. (2013) of studies that address eating behaviour in self-service setting highlights this issue. Skov et al (2013) discuss the matter within a theoretical framework of choice architecture, part of Nudge Theory. Taking twelve studies, sourced from a search across twelve different databases, revealed that of the studies

factoring in issues such as bowl shape, portion size and utensil size, the results did not conclude any healthier eating habits.

The only caveat to this is that the review only details one experiment (written up in two separate papers, Freedman 2011; Freedman and Brochado 2010), where portion size was the specific measure (Skov et al. 2013). The experimental design was to pair different portion sizes with corresponding nutritional information. The experiment was more to do with reducing portion size to save costs and food waste in a pre-paid, all-you-can-eat catering environment. It also showed a reduction in the consumption of the high fat, high salt choice of French fries. The average level of food consumption and plate waste decreased. The nature of vending would not allow for a study of this factor as users do not typically consume food at point of sale.

Portion size may be incorporated at a later stage, using a similar method to Freedman and Brochado (2010) where plate sizes, or in this case snack and drink item sizes, were drawn with nutritional values adjoining them. This requires further consideration. It is important to recognise that portion size is a significant concern, as the guidance provided by the Department of Health (DoH) (Gov 2014) incorporates it in policy development. This was confirmed by DoH representative Jane Crossley, Senior Strategy and Policy Manager Patient Environment Team Department of Health. Following on from this, the trial mentioned in the DoH report *Establishing Food Standards for NHS Hospitals*, was initially used to create a prototype that would allow for portion size to be input as a variable to the model (Gov 2014). Eventually, the idea was not implemented as it cannot be validated.

If portion size were to be incorporated into the nutritional profiles, the idea would be to attribute points to each potential food portion size to account for the different measurements of millilitres and grams in food and drinks separately. For example, 500ml drinks might be 0.5 points, 1 litre 1 point whereas for food it could have been 100g is equal to 1 point, 50g equal to 0.5 points etc.

Once points for portion size have been attributed to each product, this could then be added to the nutritional point to give a new total that factors in both the overall nutritional value of each item based on the FSA Ofcom model as well as portion size.

In practice, this approach would have to be discussed with the extensive group of dieticians who originally developed the model. Portion size is completely unrelated to the nutritional scoring system and would skew the model without linking the new addition to the existing and detailed methods of calculating scores for each nutritional variable, from sugar to fibre etc.

6.4 Discussion of contract factors

An example of the result of output-specified contracts in catering in the NHS is that allergen information about food must legally be made available on request, as is also the case in the US (DoH 2014, Redhead and Williams 2010). At Barts Health, the contractor is free to meet this requirement in any way: to store information online, or on printed menu cards, for instance. These two approaches may produce better or worse levels of consumer awareness of allergens. However, contractually either is acceptable so the contractor is free to choose the cheapest option. This shows that contract management alone is not enough to ensure the best possible service.

In relation to vending, a key concern is that automated food and drink vending are used as a cost-efficient way to deliver out-of-hours catering to staff. This method of providing retail service is in line with the NHS Standard Contract, and vending machines are ideal as they do not require continuous staffing and the products have long shelf lives, so wastage is minimal. This is

attractive where service has a low turnover and can, therefore, be costly to run with little profit returns.

Although the contract is being met, traditional vending services are not a healthy way to nourish staff out-of-hours. Understanding the way that staff are using vending machines is key to evidencing the need for change in this area.

The impact of the contractual structure can prohibit information sharing, creating hurdles to effective service delivery. Service records held by contracted and subcontracted service providers, such as costs of running services, supply chain information and retail profits, may be contractually protected from the NHS. Even the locations of vending machines are not decided by Barts Health, but by the PFI partners who built and manage much of Barts Health properties, Capital Hospitals Ltd (CHL). Contracted service providers such as Carillion plc are given broad goals that meet only the legal requirements of service and these can be interpreted in the most cost effective way. This is called an output-specified contract which helps keeps costs to a minimum.

The existing contract is not adequate to implement policy recommendations such as selling and promoting healthier food and increasing labelling. Out-of-hours staff catering highlights the dilemma as FMs are being asked to deliver value outside of the contract structure, and, therefore, have little power to ensure its successful implementation. Running the out-of-hours catering service for smaller amounts of people is less resource efficient and is also not a part of the core NHS offering, which takes precedence in the way services are managed by FMs.

Complex governance agreements between the Trust and several third-party governance organisations can prohibit positive change. The impact of the contract structures can also prohibit information sharing as service records are held by contracted and subcontracted service providers. The costs of running services, supply chain information and profit level may be contractually protected which means FMs have no access to the information. Contracted service providers who subcontract vending are given broad goals that meet only the legal requirements of service, and these can be interpreted in the most cost effective way, to help keep costs to a minimum. In a retail service like vending, this is a poorly-aligned approach, as the profits from service might be used to ensure subsidies for healthier products rather than being drained out of the NHS by third party contractors.

Guides such as the GBS can be written into contracted service provider agreements, and can be used to communicate service level agreements (SLAs) and key performance indicators (KPIs). However, the GBS itself is undergoing pilot testing and active debate as to its usefulness. It is at an early stage of development. A singular mode of advising on public health communication in vending services is necessary.

Finally, the contract can be used to excuse a lack of initiative and effort on both sides towards improvement. This is unacceptable and unnecessary. In launching the primary research project for point of sale interventions, this research was working outside of the current contract specifications. There is no current agreement for contractors to provide support or resource for public health-driven point of sale designs. Similarly, in surveying out-of-hours service users, the research was exploring a potential service improvement that is outside of the current contract agreement between the Trust and its catering supply chain to provide out-of-hours catering. The research interrogates what out-of-hours catering is in detail from the user perspective, and holds it against the policy driven standards for public health. Immediately this reveals a gap between contracts and policy that leaves Trusts vulnerable to criticism.

Conducting research that is not restricted by the specifications of the contract is essential in moving the service from current level of compliance towards potential future tightening and increased requirement for compliance, or perhaps even a radical change of service to protect public health and ensure the NHS promotes the correct image in its premises. This research proves that it is possible to conduct this type of research successfully and that buy in can be achieved outside of rigid contract frameworks.

6.5 Reflection on policy through international approaches to public health and vending

The French and the US approaches to vending, banning it all together in the former and allowing relative freedom of use in the latter, offer polarity within which to consider potential development of policy in the UK. It would be overly simplistic to say that the French approach is better than the US. Firstly, the US has a far more serious problem with chronic obesity, for example, and so must deal reactively to weight gain and with ingrained poor eating habits. Governments must set achievable and meaningful targets that reflect the current state of public health in the country at the time, and these may change.

Secondly, it remains unclear from the literature what the impact of vending machine bans on revenue in the French example, or the cost of service change. Thirdly, considering the NHS, it is unclear how one would operationally deal with a vending ban, given the need for out-of-hours catering. Vending also supplies much needed water around the hospital, in places such as A&E, which would need to be suitably replaced.

Finally, dealing with adult populations, the end user perception of a vending ban is more of a factor than in schools. It may be argued to be unethical to remove choice all together. It might equally cause unrest and dissatisfaction among service users, something frontline FM staff would bear the weight of on a daily basis. All of these unknowns would greatly impact FM services and the way they are designed and run.

One last consideration it that, although vending machine services are not strictly there to service patients, often malnourished patients might be more willing to eat the types of foods sold in vending machines, and people may find emotional comfort in them too. The Nutrition in Action Team (NAT) at Barts Health themselves expressed their concern over this matter during consultations with this researcher during the project. Increased craving for salt has even been linked by researchers to attempts to moderate depression (Goldstein and Leshem 2014)

Given that France and the US both used BMI as a measure (if in very different ways), one might assume that this research would seek to incorporate BMI into the work. This is feasible given that BMI data was available about staff at Barts Health. A recent review of vending research stated that ‘research is urgently required to better understand the features of successful point-of-purchase nutrition interventions and whether these interventions can reduce BMI or prevent weight gain’ (Grech and Allman-Farinelli 2015). The feasibility and usefulness of doing this is yet to be evaluated, given the more immediate research need in the areas listed at the beginning of chapter one. BMI is also a remote measure considering FM performance and service design measures that are in place.

Further ideas for developing measures of public health in vending

Biometric data and technologies to measure and influence it are a rapidly expanding area of research. Biometric data is a central part of technology design aimed at effective communication in contemporary research with cutting edge examples including eye tracking and fMRI

technologies (Ripoll et al 1995, VanRullen and Thorpe 2001, Ballard et al 1997, Turner et al 1998, Coe et al 2002, Lim et al 2011, Recarte and Nunes 2003, Law and Gold 2009, Ditterich et al 2003, Glimcher 2003, Vaeyens et al 2007, Krajbich and Rangel 2011, Pezzulo and Barca 2012, Vargo and Lusch 2004, Huddleston et al 2015, Chandon et al 2009, Feiereisen et al 2008, Clement 2007, van der Laan et al 2015, Zhang et al 2009, Otterbring et al 2014, Kuai et al 2013). The work on FMRI scans and visual fixations shows that placing products in prominent easy to see locations may improve sale of products there.

One must consider how these technologies will influence and potentially improve public health agendas, service design and positive change to people's long-term health in public sector settings in future. The level of user information that might be gathered at point of sale for example could be highly diverse, allowing the machine to select products appropriate to the user.

Another area of research that was not formally developed but that was undertaken by this research in the course of the project was in engaging the sponsor company at an operational level in their work around catering service improvement. For example engaging contractors in new government policy guidelines. This researcher produced a policy pack for those tendering for the new soft FM and retail contracts. The pack reported about the research work done, including all areas of research on policy, strategy, supply chain, point of sale and end service user research. The researcher attended meetings with senior management teams around contract design, to plan the soft FM and retail catering retender. Key terms like 'healthy' and 'snacks', or 'sweetened', were still undefined in the proposed contract, initially. This was fed back formally in the strategy development and contract consultation meetings with senior management. Terms such as these would surely require definition, when, for example setting, SLAs or KPIs around healthier vending.

This aspect of the project was periphery but in understanding what creates successful research it was essential. Part of the research is to reflect upon the process. One aspect of research that has been successful in this case is continually engaging in the periphery research activities that add value to the project from the perspective of the sponsor. This reflective element of the project could constitute its own area of research and was too complex to formally reflect on given that the research problem was to improve vending services.

6.6 Development of the FM research context

FM research can contribute to the adjacent disciplines to help understand design in use, the end user and their environment better, as this is where FMs operate and hold valuable expertise (RAE 2015, BIFM 2013, Martin and Guerin 2006, Nenonen and Sarasoja 2014, O'Brien 2014, Lockton et al 2010, 2008, McCarthy and Write 2004). In the example of vending services, FMs championed this research project as providing critical insight into catering in the NHS, which was being called for by government (DoH 2014).

Evolving out of commercially funded research programs, FM research communities have recommended a clear delineation of methodological issues that meet organisational demands, the adoption of a recognised set of scientific methods, more hypothesis testing, robust data analysis techniques and reporting methods, and more valid conclusions (Nenonen and Sarasoja 2014, Junghans and Olsson 2014, Pullen et. al. 2009, Mclennan 2004). This is vital. However, in contrast to this statement, the discussion of technologies of service communication so far has emphasised social, psychological and user-focused approaches. The methods of analysis must compliment and retain focus on these factors. This research has attempted to maintain a focus on merging technical and social systems. There has been less emphasis on strictly scientific methods development, and more on solving the sociotechnical problems.

Although FM, in the context of this research, is heavily concerned with people and social systems, FM research has thus far developed largely in line with objective, scientific ways of thinking (Price 2002, Pullen et. al. 2009). The underlying logic of FM research is defined by the nature of science itself; pertaining to a central problem, with items considered to be facts, explanations, goals, and theories related to that problem, and, like FM, science has developed as 'a response to the demand for specialists in capitalist societies' (Moran 2002, Wagner et al. 2011, Klein 2006). Like any young profession, FM has sought out 'finance and status as well as business attention', and scientific methods offer a way to harvest knowledge and justify such increased nationalised and commercial funding and business attention (Price 2002, Moran 2002, Strijbos 2010, Klein 2006, Sullivan et. al. 2010, Junghans and Olsson 2014, FM Link 2014, ICE 2014, Pathirage et al. 2008, Mclennan 2004, IFMA 2012; Nenonen and Sarasoja 2014).

This research has at its' centre been about FM services, and has been carried out in line with the requirements and constraints of FM practitioners. FM research is traditionally aligned with hard FM and science based (deductive) research methods (Campbell 2017). An 'evidence based' scientific, hard FM body of knowledge responds to organisational problems, in the form of empirically-tested theories, business cases, best practices, financial savings proposals, and decision support tools on different levels that are strategic, tactical and operational (Price 2002, Pullen et. al. 2009). The development of FM knowledge in this tradition is, as a result, well-aligned with a drive from governments, private industry and policy across the world to engage academic institutions with surrounding commercial markets, fuelled by underlying increases in competition between academic institutions as well as competing national economies (Rudzki 1995, Hemsley-Brown et. al. 2006, Palfreyman 2004).

Soft FM research

Research agendas and research approaches to do with soft FM are less easily quantified. Soft FM services like cleaning and catering are also more likely to the subcontracted, so this adds a new contract-focused set of agendas to soft FM research (Cotts et. al. 2010 p232-233). Soft FM research problems are rooted in scientific research thinking and often centred on contractual performance measures. Organisations might have limited access to outsourced data sets, which makes research even less likely to happen from an in-house FM perspective, as is the case in this research project. This lack of soft FM research is exacerbated as the humanities research approaches that might compliment soft FM research are less likely to gain government funding, compared with commercially competitive science-based research (Fredericks 2010, Moran 2002, Huutoniemi et. al. 2010). These combined barriers make it difficult to see how one can research soft FM problems from the in-house FM perspective, with public health agendas at stake. These pertinent issues to FM practice do not fit neatly into contractual analysis or scientific methods.

One of the most influential current approach to soft FM research is service management (Campbell 2017 Grönroos 2007). It offers a framework of analysis that is well suited to this research problem, as defined in Chapter 2 (Figure 92).

Figure 92 Service Package (Fitzimmons and Fitzimmons 2011)

This research project built from the same service management research that is used in soft FM research. This researcher would argue that the methods used in the primary research can aid the development of user-based research approaches. While these have traditionally been related to soft FM, hard FM practices require a large amount of end user and other stakeholder communication to ensure effective service delivery. Therefore, this researcher would argue that the methods developed in the project, stemming from soft FM research problems are applicable across FM practices and not only soft FM.

Service management alone is not a comprehensive enough basis to develop this broad user-based FM research on. It has been criticised for essentially applying ideas about machines and theories from manufacturing to people (Kumar et. al. 2014, Sampson and Spring 2014, Goyal and Pitt 2007, Cardellino and Finch 2006, Da Silveira et. al. 2001, White et. al. 2010, Lehtonen and Salonen 2005, Graves et. al. 2012, Nenonen and Sarasoja 2014, Loosemore 1995, Sarewitz 2010, Nutt 1999). This echoes the problems of systems thinking in 1960s high rise design (O'Brien 2014). It is felt, as in adjacent fields of architecture and engineering, that there is room for exploring and developing the kind of user-centred research discussed earlier (Figure 12) into FM research for a more robust set of approaches to service communication and research methods (McLennan 2004, Coenen and von Felton 2014).

Ways of joining up research methods across hard and soft FM

Reasons for crossing the traditional divides between disciplines and research approaches, are being driven by industry demands for practical, commercially attractive research moving beyond traditional, purely science-based responses (Wagner et. al. 2011). Defining and researching the user from a humanities perspective, and end user environment, must harness this drive and elaborate on how methods can be assimilated from humanities into existing, heavily science-based methods of FM research.

Among many research communities, there is a shared feeling that divides between academic disciplines and paradigms of hard and soft research must be brought together, including research work and day-to-day practices in research communities (Nenonen and Sarasoja 2014,

Davies 2011, Moran 2002, Strijbos 2010, Fredericks 2010, The Bartlett 2014 Wagner et. al. 2011, Klein 2004, Klein 2006, Falk-Krzesinski et. al. 2011, Hadron et. al. 2010, Huutoniemi et. al. 2010, Nenonen, Truffer et. al. 2008, NRC 2004, Culligan and Pena-Mora 2010, Huutoniemi et. al. 2010, NRC 2004). This can ensure meaningful crossing of disciplinary boundaries takes place.

One of the challenges is group working within research projects as a hard/soft paradigm means different definitions, models, methods and even journals in which they publish from within disciplines (Wagner et. al. 2011, Klein 2006, Hadron et. al. 2010, NRC 2004), It is crucial to discuss research across these boundaries and find overlapping themes, practices and resources that each side lays claim to (Price 2002, Pullen et. al. 2009 Martin and Guerin 2006, Klein 2006). Improved cross working research practices might enhance one's ability to produce, find and publish relevant work in a timely manner, or acquire funding from different disciplines and their connections, to define the inputs, processes, outputs, and outcomes of one's research (Davies 2011, The Bartlett 2014, Klein 2006, NRC 2004, Wagner et. al. 2011, Klein 2006, Huutoniemi et. al. 2010).

Several methods have developed to help this process of cross disciplinary research. Dedicated methods such as bibliometrics and visual mapping of disciplines and research, find ways to factor in differences in granularity and dimensions of measurement and assessment of research practices (Wagner et. al. 2011). Terms such as interdisciplinary, multidisciplinary or, transdisciplinary research are used to allude to the wide range of efforts being made to bring together and forge new research practices. This is work being led by research administrators and policy-makers (Huutoniemi et. al. 2010, NRC 2004). It ties with mixed methods research practices, discussed in the Methods chapter. This project crossed many disciplines and so these high level discussions about the practice of research are related to this project. A project with more scope would have developed this discussion further, although the literature is itself in a formative state.

In FM practice, cross-departmental working can be viewed as a parallel. In research terms, science deals with how best to bring together groups of researchers to conduct research, and might be harnessed to create dedicated FM research agendas and structure projects (FalkKrzesinski et. al. 2011, Stokols et. al. 2010). In an organiosational setting, Mullins and Christy (2010) metioned in section 2.3 of this document applies.

In publishing FM research, databases and technologies are necessary to help identify FM-related theory too. FM research groups are in the early stages of collecting and categorising the broad and varied range of processes involved in FM and linking them to different areas of research and associated methods in order to begin the process of creating an effective set of FM theories (IFMA 2012, Nenonen and Sarasoja 2014, Sullivan et. al. 2010, Pullen et. al. 2006, Price 2002). Nenonen and Sarasoja (2014) bring discussions about interdisciplinary research together with FM, focusing on the challenge in FM in Finland in the development of competencies towards shared understandings, unified methods and intensive collaboration, not only between industry and research or internationally but in knowledge exchange across disciplines as well (Nenonen and Sarasoja 2014). This kind of approach to FM is perhaps influenced by interdisciplinary research in the same country such as the AFIR (Klein 2006). No other relevant peer reviewed work being done to link cross disciplinary research practices, TDR and FM was found in literature searches.

Martin et al. (2006) have produced a search engine for designers of infrastructure, seeking papers that report on the design outcomes and evidence of how design affects people, an essential FM-based problem (Caren et. al. 2006). They report on the problem that designers face, that research of buildings in use does not communicate well with designers or make

understandable criteria for their work, highlighting the gap between research and practice that more robust FM research methods might help fill (Martin and Guerin 2006, Caren et. al. 2006).

A final consideration in creating meaningful FM research is that commercially sensitive findings in research can slow or prevent production and publication of meaningful and useful research (Nenonen and Sarasoja 2014). This is especially important given that FM is inherently an applied field of research. Given that many soft services are outsourced, active consideration is required about how to bring commercially protected data and remotely managed teams with in-house expertise to create a unified understanding of FM problems.

6.7 Research limitations

There were several limitations to the research. Firstly, the sample sizes of the two primary pieces of research were not the same, limiting the potential to create crossover analysis. The survey addressed the whole of Barts Health NHS Trust, the point of sale intervention addressed only St Bartholomews and the Royal London. Secondly, in the vending point of sale experiment the intervention period for product range interventions was not large enough to make meaningful conclusions about the impact of the interventions long-term. Thirdly, there was a lack of sales and revenue analysis. This would have empowered more decision making at contractual level. The research prioritised nutritional measurement and was not able to complete further analysis of sales within the project timeframe and focus. In future, it would be favourable to trial more interventions with different intervention designs, perhaps colour an entire row of products in one colour.

In order to focus more on out-of-hours staff, it would be optimal to have timed sales data for product purchases. This would mean that the interventions could be tested to see what time of day they were most successful and if there were changes in behaviour between out-of-hours and operational retail catering times.

6.8 Contributions to knowledge

There were six areas in which this research contributed to the creation of new knowledge.

1. The research responded to a call for more understanding of how to influence healthier user choices in vending interventions, as well as a call for more understanding of how to influence vending choices in healthcare settings specifically (Skov et al 2013, Hua and Ickovics 2016). The point of sale research experiment in this research trialled vending machine interventions in novel ways to encourage healthier eating habits. It showed which of the interventions were and were not suitable in an NHS setting.

2. The research built understanding around the interventions that was novel, as it factored in location and its designation as a staff or public area. Understanding if these variables had any bearing on the success of these types of nudge interventions has not been trialled before for public health.

3. The use of fixed effects modelling was novel for research on vending in healthcare and is a new way to analyse findings in nudge interventions for this setting (Thaler and Sunstein 2008). Similar methods of regression modelling have been used to measure the association between school vending machines and children's BMI by socioeconomic status, showing that the analysis methods are suitable for comparison across public health and vending research (O'Hara and Haynes-Maslow 2015). In this case, using mixed-effects modelling allowed the interrogation of conditional variables

to see whether the characteristics of the location or intervention type made an impact on the efficacy of the intervention outcomes.

4. The nutritional model that was used was trialled in a novel environment. The prior examples of the application of the Rayner across-the-board nutritional profile report favourably. However, none have tested it as a vehicle for point of sale vending labels, and not in healthcare (ANSES 2015, Jewell 2008, Sloane 2014, Bolton NHS Foundation Trust 2010, Rayner 2014, Rayner 2013). Vending is uniquely suited to across-the-board nutritional profiling. Having a single score for each product that can be displayed on the machine is ideal as there is limited space to look at package labelling at point of sale for vending. Therefore, the research makes a novel contribution to the development of the application of the Rayner across-the-board nutritional profile for vending service improvement where the intended outcome is healthier product choices.

5. Another contribution was made through the catering survey, which collected and analysed end service user feedback. This makes a novel contribution to vending service improvement literature in the NHS for staff, as there is little formal collection and analysis of end user opinions available in the literature, and it was invaluable in strategic service planning in Barts Health. The same approach and the findings may be used to contribute to discussion at a national level about catering for night shift staff, adding to the evidence base for positive change.

6. The final area of contribution to knowledge was in the development of service design analysis in FM (Campbell 2017). The research advocates the capture of invaluable, in-depth personal knowledge about service design through scoping and engagement with the subject. It suggests that coupling this with robust statistical tests and quantitative analysis that drives service change is optimal in FM service design research. Public health agendas are only one of many agendas that FMs must adapt to in the varied organisational settings where they operate. The methods and research approach applied in this research are highly translatable to other FM service design research problems.

In a broader sense, the research meets the gap between strategy and practice, developing methods and approaches to achieve this. Some specific gaps filled in vending services were the adoption of a suitable nutritional profile and detailed user opinion review to illustrate goals for change, as well as evidence for why and how nudge style interventions were successful. The research approach created a blend of actioned research and evidence-based quantitative analysis and actively intervened to bridge the gap. This mix is ideal where FMs need to understand and influence operational delivery of strategy to meet new governance demands within a restricted management structure.

Inherent to the research approach has been the role of communication. Communication was essential in influencing and understanding behaviours, as well as providing the measures and techniques needed to operationalise and analyse data. The research methods have now been trialled and used to link strategy, policy, contracting and supply chain auditing to the business framework and deliver and honour meaningful operational changes towards public health outcomes.

Finally, an outcome of the chosen research approach, combining communication, actioned research and quantitative analysis, focusing on public health and not commercial outcomes, was the cooperation and resource given by subcontractors. The engagement fostered was outside of the contractual agreement. Having access to the sales database for vending and the dedicated

time of the subcontractor goes against convention as it is not within the contractual agreement to do so. The level of subcontractor and supply chain engagement, time spent face-to-face and trust built between stakeholders and the primary researcher was pivotal to the research.

One may speculate as to the reasons for high levels of buy in. It may also have been due to the leadership and strength of the working relationship between the industry supervisor, who was at an appropriate associate director level to command business attention, and the primary researcher. It may equally have been due to strongly aligned research and organisational goals. Thirdly, it may have been the result of the forward-facing nature of the research, an opportunity to lead amid anticipated increases of the role of public health agendas in non-core NHS services such as vending. For these reasons, the project was well integrated and strongly applicable to the present problem of vending service improvement in the NHS towards public health agendas.

6.9 Conclusion

In a highly visible service like vending, the sight of chocolates and crisps for sale does not support the ideals of healthcare, and staff, patients and visitors buying unhealthy food from retail outlets on NHS sites sets a poor example for preventative models of healthcare (İnce Güney 2014). From the outset, the research surmised that the fact that vending machine point of sale removes the need for face-to-face transactions can mean transactions go unnoticed and perhaps even manifest into vending being an inherently taboo or immoral service (Segrave 2002). The research went on to shed light on the impact of vending on public health agendas in the NHS and found they do play a significant and detrimental role, especially for staff working night shifts. It also showed the large volume of sugar, saturated fat and sodium being consumed via this often forgotten and difficult to standardise retail outlet.

Both pieces of research bore witness to the need for change, providing quantitative evidence. The project strove to provide the kinds of linear rational models that the public sector can use to influence and positively change decision making and to contribute, through FM service design to preventative models of care and public health (Oborn et al 2011). The research was conducted in order to inform service improvement goals for in-house FMs, collecting and analysing data that would be valuable in deciding the best courses of action at all levels from the in-house FM perspective. This is because FM is most importantly a function to maintain and develop the agreed services which support and improve the effectiveness of the NHS's primary activities as a carer of health (IFMA 2012, BSI 2006, FM Link 2014, CEN 2006, Prodgers 2009, Davies 2011, Hall 96, Mclennan 2004, Coenen and von Felton 2014).

Data-driven communication systems such as outsourced service contracts are often reliant on staff engagement to understand how to change services through reporting and feedback. This was noted as a particular area for improvement at Barts Health and one which the staff survey contributed towards (Marmot 2010). For example, the staff survey captured staff feedback which was crucial to understanding the service faults and was included in the food and drink strategy for the Trust. Contracts and policy guidance in place to ensure compliance and effective governance must be informed by these kinds of ground up analyses to ensure resource is prioritised correctly. For example, a food education need was detected among night shift staff that, left unmet, could negate any efforts to provide better catering services and damage retail profits in the process.

The primary research carried out was a rare opportunity to test the efficacy of the point of sale interventions and understand formally if they were appropriate in a healthcare setting by using in-depth statistical analysis. The results showed several promising changes that could be made amidst the rigid management frameworks in place. The changes were relatively cost-free, and resource-lite to implement. Until any more drastic changes to the way that vending machine

services are governed are made, these changes present a positive compromise to the tension between commercial and public health agendas. Given that vending is a non-core service, these changes should be seen as a successful effort to improve and should be embraced, retested and developed further NHS wide.

Finally, activities in this project were focused on the user end of service communication and engagement and on understanding the impact of vending services on staff. This is where FM services create their value-add in organisations. Placing quantitative research at the heart of a more complex and qualitative understanding of this everyday context meant that the research gained clarity and applicability. The in-depth knowledge of the operational and contractual restraints allowed the research to work around problems and design solutions that had real potential to be used. Ensuring that ample consideration was given to the extenuating and contextual factors of the vending services as a system was also a way to align values of different groups in vending services, create an overall positive outcome and avoid creating a solution worse that the symptoms of the problem (Churchman 1967, Rittel and Webber 1973).

Some of the unintended outcomes of the project were also positive, if difficult to quantify. For example, water was added to the machines in the children's day care unit. Renal were given a bespoke set of products that fit their patient profiles, as the previous one was in fact life-threatening at certain stages of treatment. A healthy product range was placed into maternity on request as well. Vandalism issues impacting the vending machines were escalated and communicated and discussed more frequently, leading to more in-depth consideration of how the spaces where vending machines were situated were being policed. Without taking a hands-on approach to the project, these benefits would not have been made possible and, most importantly, the project fostered communication between FM and clinical departments, contributing positively to the open discussion and partnered working throughout the strategy development and contract renewal phase.

The changes needed in vending services may be unresolved but the underlying systems of communication have been enriched through this project, and the evidence base for change strengthened.

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Appendix B MRES Dissertation

Master of Research Dissertation

University College London

Virtual Environments, Imaging and Visualisation

Utilising Technology to Achieve Staff Engagement

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Abstract

This research reviews the utilisation of technology to achieve staff engagement. The research investigates a staff engagement project run by the Estates Department of Barts Health NHS Trust. 'Operation Turn off equipment, Lights out, Close doors' (TLC), aimed at engaging clinical staff to take energy saving actions, and improve patient care in hospital clinical areas in the process. A more considered use of technology in TLC can aid achievement of the project goals, changing the way that staff use the building and furnishings to save energy. Utilisation of technology in TLC can subsequently be improved as it is introduced into additional sites.

Existing theories provide frameworks and techniques, to understand and develop the utilisation of technology to achieve staff engagement. Four areas of discussion were identified in this research, *the user, the data, the aesthetic and the process*. Underlying all of these are the intended outcomes of the project. Conducting a case study about TLC revealed that the *aesthetic* of the technologies used in TLC is not currently a strong element in the project. There are opportunities to take a more considered approach to the *aesthetic* representation of the messages in TLC, using technologies, to help engage staff better and potentially to cut costs of face to face engagement.

Implementation of technologies in staff engagement projects is however complex, given the real life environment. Often, the literature does not provide reflection upon the operational requirements in place to tackle complex, real life organisational scenarios such as in TLC. As a result, the wider range of technologies in use, such as email servers or bespoke medical equipment, are not considered. Another facet of this omission is that there is little guidance on how to actively factor in the intended outcomes of a project such as TLC, to link the utilisation of technologies to the core motivations of those involved in a meaningful way. Therefore, this research provides a balanced approach to the task of evaluating the utilisation of technologies in TLC, drawing upon both the literature available, as well as the insights gained from taking a longitudinal approach.

A range of technologies are discussed, from medical equipment, to administrative tools, hard furnishings, bespoke communications technologies aimed at encouraging staff engagement and used in reporting outcomes, to monitoring performance measures.

Contents

2.

Introduction

2.1 Introduction

This introduction outlines the wider motivations of the subject of this research, a staff engagement project called 'Operation Turn off equipment, Lights out, Close doors' (TLC). One of the motivations of TLC is to reduce energy consumption, linking strongly to ideas about 'sustainability'. Sustainability is taken here to mean 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs', this definition remains widely used today (1, 2, 3). There are three commonly accepted kinds of sustainability, also known as the triple bottom line: environmental, economic and social (4). TLC relates to all three kinds of sustainability, discussed below.

There is a well established relationship between man made carbon emissions produced by energy usage and global warming. Although this correlation is not uniformly believed or respected (5), it is agreed upon by an overwhelming number of scientists and has for some time impacted the way in which businesses are run (6, 7). Carbon Reduction Commitment (CRC) is the resultant body of governance in the UK, and in large part dictates how the NHS defines and deals with its' carbon emissions.

The NHS energy bill is £630 million per annum and energy prices and the demands on healthcare facilities are increasing (7, 8, Appendix B). The projected annual energy savings made possible through behaviour change initiatives in the NHS is substantial, at £35m per annum (Appendix A). Achieving reductions in energy consumption is carried out by the FM function (often also called the Estates Department) at Barts, as is often the case in UK organisations (9).

FM is here understood to be the 'integration of processes within an organisation to maintain and

develop the agreed services which support and improve the effectiveness of its primary activities' (10). Often FM is viewed as being concerned with building infrastructures alone, that is the buildings, furnishing and plant equipment in them, however this ignores the building users who are pivotal in determining how resources are used and the amount of energy consumed (11, 12, 13, 14, 15, 16, 17, 18).

FM at Barts, as with many in the UK have traditionally focused on the building fabric alone, engineering and plant equipment (Appendix A). Launching TLC demonstrates the exciting potential of FM to expand upon this focus, to: firstly impact positively on environmental change, secondly serve economic drivers and legal constraints and lastly to potentially increase productivity and staff satisfaction, all of which aids the core business of patient care by creating a thriving and innovative infrastructure for people to work in (19).

The focus on making reductions in energy consumption, specifically through staff engagement, is linked to social sustainability. Staff can contribute to making the hospitals more energy efficient, savings can then be assessed and as will be shown in *5.1 TLC Outcomes*, patients can be better served by an energy efficient hospital (20).

The wider goals of the NHS are represented in TLC, geared towards 'driving efficiencies, improving patient experience' (21). This echoes recent governmental ambitions for a patient led NHS, referred to as experience based design (EBD) (22 , 23, 24, 25).

One of the core motivations of TLC is to show how partnerships can aid the NHS in achieving efficiency, to contribute towards a collaborative model for sustainability in the NHS. Both external companies and internal teams could achieve more together than separately.

2.2 Problem Statement

The aim of this research is to understand the ways that technologies can aid TLC, engaging staff in order to improve patient care and reduce energy consumption.

The core actions of TLC are to:

Turn off equipment
Lights out
Close doors

Staff who are being asked to engage in the TLC actions work in the clinical areas of the hospitals, mostly on wards. Encouraging staff to engage with and carry out TLC actions is more complex than might at first be imagined. This s a core issue throughout this research.

Healthcare settings are unique in that they are medical areas, and the various treatments performed in them create further diversification, moreover TLC links with a set of generic processes, requiring a balance between the two. Therefore standardisable and non standardisable elements of TLC are highlighted.

TLC will increasingly be reliant on technologies as a means of project delivery. Using technology badly, in a way that does not support meeting the project goals is a risk, as it negates an opportunity to engage staff, particularly in instances where technology is being relied upon heavily as a method of communicating the messages of TLC. Technology will play an increasing role in the delivery of TLC and it will be launched in more hospitals in the future. TLC will be sold as a commercial project.

There will be three packages offered to hospitals who purchase TLC as a commercial project. The first package has already been delivered and entails a high level of face to face engagement, this has an attached cost, the initial development and first time that TLC was implemented using face to face engagement alone cost £95,000.

The second package offered to hospitals will entail less face to face engagement, creating a need for new methods of delivering TLC. In this instance technologies can be utilised in a more sophisticated way, to deliver the messages of TLC and foster engagement, acting as a pedagogical link between behaviours and outcomes (26). The use of technologies to educate is relevant to the NHS staff being asked to carry out TLC, as well as educating governing bodies about the project. This is a complex process and has proven problematic in prior research.

The third method of delivering TLC will be entirely without face to face engagement, making the use of technologies to deliver messages and information a crucial factor in the success of TLC.

This research project aims to understand how technology is already being used in TLC and then decide how it can better be used to meet the project outcomes given the future plans for implementation. The problem is that staff engagement projects are complex as they happen in real life scenarios and risk of failure can be high.

One particular area that is of interest that might help mitigate some of the risks of staff engagement, that will be explored in more detail is infographics. Edward Tufte is a central figure in the field of infographics, who describes it as a tool to convey narrative meaning (27, 28, 29, 30). They are often computerised. The range of styles is often now referred to under the term data visualisation (data viz). Visual representation of information can be used as an effective way of engaging staff. Most importantly, technologies, including visualisations can both support face to face engagement and are a more cost effective way to engage staff than using people.

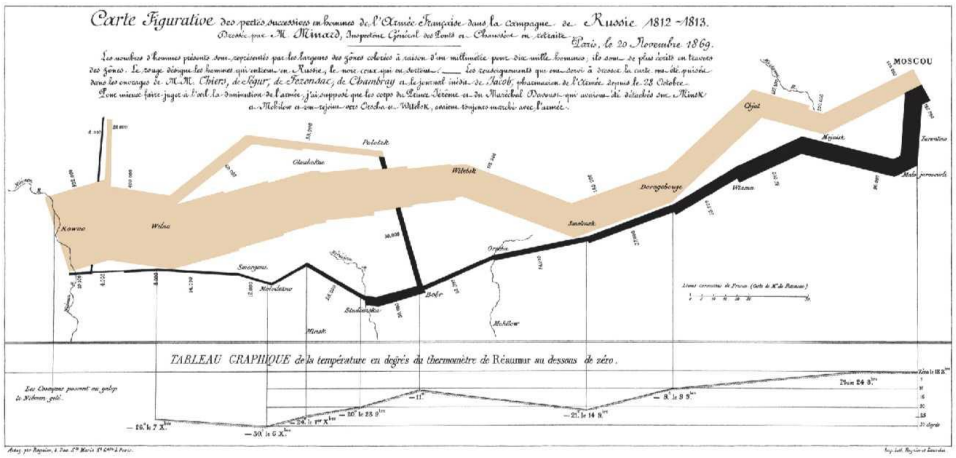
3

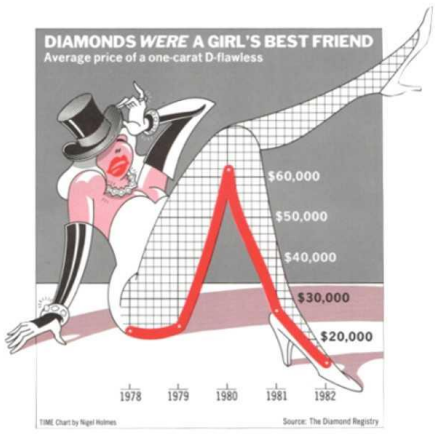
Literature Review

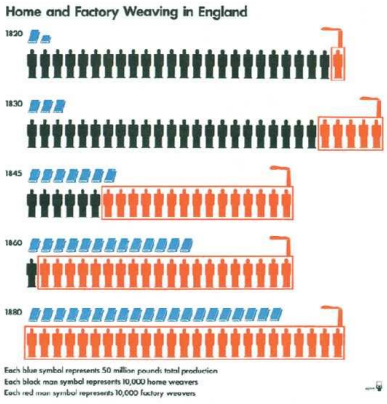
3.1 Technology that informs

Infographics are a popular method of delivering information in an easy to grasp and immediate way. Up until as late as the end of the 1970s they were being presented as hand drawings, after which time computers have become increasingly prevalent (30). Software packages are increasingly available to aid the user in creating sophisticated infographics with more complex images and data sets, to enhance their ability to engage people.

Styles of infographics vary between those produced by people with a background in statistics, in the arts, and those focusing on the user perspective (30), demonstrated by the three images on the next page:







Infographer	Creators Background	Style	Infographic Focus
Holmes (top left)	Journalist/ graphic designer	Sensationalist, catchy	Art/ end user
Neurath (top right)	Soiologist/ good with statistics	Easy to understand	End User/ statistics
Minard (last image)	Statistician	Minimal, geographic reference	Statistics

At one end of the divide is data art, often utilised in marketing and media (31, 32). This kind of infographic has been criticised for having too much 'ink on the page', which Tufte and others since

criticise as being unnecessary (30). At the other end of the divide, infographics are presented using minimal colour and imagery, often the style preferred by statisticians, in for example government reports.

More recently, Cairo, who is another central figure in infographics, argues that a lot of ink on the page can improve recall of information compared to more sparse drawings (27). Cairo describes the main aim of data viz is to 'build a visual structure that the human mind can understand' (27). Cairo places aesthetics and the user in the foreground of his discussion about infographics, asking questions such as whether people take as much notice of those less attractively delivered messages.

Infographics theory focuses upon characteristics of visuals such as:

- Representing personal or group information
- 2D/ 3D
- Realistic/ abstract
- Personal/ private
- Animated or static
- Choice of colour and shade
- Shape choices
- Time (spent viewing infographic and time as a variable represented in the visualisation)
- Composition of the visual (direction of lines, placement of shapes, proximity etc)

(27, 30)

All three approaches to infographics are incorporated in these criteria, aesthetic, the user, the data.

The way that information is presented in TLC is a crucial factor in people's ability to understand the project, to inform members of staff of the core messages, report to governing bodies about the successes of the project and to encourage more hospitals to implement TLC in the future. Choosing how to represent information in a way that people can understand and learn from deserves careful consideration and styles are split between those statisticians, artists and those concerned with the user perspective. Infographics brings together disparate expertise from these areas to provide guidance about how to make information visual. Using infographics might reduce risks of failure in TLC and be used to mitigate the cost of face to face engagement.

3.2 Technology that Persuades

A key question in understanding technology utilisation in TLC is to understand its' potential to engage people. Affective interaction deals with ideas about how people interact with technology, the theory focuses heavily on models from psychology, cognitive reactions and emotional responses of those using computers (51, 52, 53). Affective interaction emerged from a field of research called human computer interaction (HCI) which similarly explores the ways that people can interact with computers.

From this quite broad set of theories, captology has arisen as a field of research, specifically geared towards changing behaviours using technologies (33, 34). To add a note here, the term behaviour change comes from psychology theory, it can tacitly imply correction, which is an undesirable association in this instance, as staff have not done anything wrong. Throughout this research the term staff engagement has been used instead, however remains closely linked with theories about behaviour change.

Persuasion is a central idea in captology, meaning 'an attempt to shape, reinforce, or change behaviours, feelings, or thoughts about an issue, object, or action' (34). It should be noted that there is some dispute between use of the terms 'persuasion' and 'behaviour change'. Some argue whether it is possible to describe technology as a social actor, questioning the validity of applying theory to a technology in place of as opposed to a person (35, 89).

Another differentiation of terms lies between 'conviction' and 'persuasion'. 'Persuasion relies primarily on symbolic strategies to trigger the emotions, whereas conviction relies on strategies rooted in logical proof and appeals to persuadees' reason and intelligence' (36, 37).

The term 'behaviour change support systems' (BCSS) has been used more recently, setting certain technologies apart from, for example those used to carryout tasks as part of the core services and operations of a business. Conviction would, it seem, take account of the formalised procedures and documentations that are needed in a staff engagement project such as TLC, set forth in order to engage permissions from management and funding, however are set apart from BCSS.

Marshall et al. (2011) researched BCSS, in light of HCI and captology. They position Experience Based Design (EBD) (mentioned in *2.1 Introduction*) at the centre of their work. EBD is a service design theory specific to healthcare, The difference in EBD is that it ties into the unique operations of the place in which a BCSS is being introduced, whereas HCI and the majority of the other

theories mentioned do not ask researchers to distinguish between settings or acknowledge operational elements of their chosen locations. This is problematic as healthcare environments are unique from many other examples of projects where behaviour change programmes might be implemented such as offices.

One of the most active areas of research into technologies that can be used to persuade people, is regarding personal informatics, most commonly based upon individualised information (38, 39, 40, 41, 42). Personal informatics is 'a class of systems that help people collect and reflect on personal information, with a continuously rising level of interest and development leading to a number of new software tools and self monitoring appliances available (41, 43, 48, 49).

Discussions about BCSS are closely linked to theories about personal informatics and captology, associated with 'the quantified self'. Although 'most existing computer systems which attempt to change attitudes or behaviours fall into just a few categories: health, mental health, and education', there may be opportunities to use technologies in energy reduction campaigns as well (34).

A comprehensive investigation was conducted by Consolvo et al. (2009) that combines many of the ideas discussed so far, about data viz design, behaviour change, personal informatics and individual health improvements. The study offers the following eight strategies for designing technologies:

Strategy	**Explanation**
Abstract & Reflective	Use data abstraction, rather than raw or explicit data collected from the user and any technologies, to display information to encourage the user to reflect on his/her behaviours by showing the user what s/he has done and how those behaviours relate to his/her goal.
Unobtrusive	Present and collect data in an unobtrusive manner, and make it available when and where the user needs it, without unnecessarily interrupting his/her everyday life or calling attention to him/her.
Public	Present and collect the data, which is personal in nature, such that the user is comfortable in the event that others may intentionally or otherwise become aware of it. Because the data needs to be available whenever and wherever the user needs it, it is likely to be something that s/he wears/carries, resides in a shared/common space, or uses while in the presence of others. The technology should not make the user uncomfortable in those situations.
Aesthetic	If the display and any accompanying devices function as a personal object(s) that may be used over time, they need to be inquisitive and sustain interest. The physical and virtual aspects of the technology must be comfortable and attractive to support the user's personal style.
Positive	Use positive reinforcement to encourage change. Reward the user for performing the desired behaviour and attaining his/her goal. When the desired behaviour is not performed, the user should not receive a reward nor a punishment, but his/her interest should be sustained.

Control-able	
Trending / Historical	Provide reasonable and accessible information about the user's past behaviour as it relates to his/her goals. Historical data should accommodate changes in lifestyle goals over time and provide for the portability of data across devices.
Comp-rehensive	Account for the range of behaviours that contribute to the user's desired lifestyle; do not artificially limit data collection and representation to the specific behaviours that the technology can sense or monitor.

(42)

The strategies and barriers set forth above are useful tools, helping to orientate an approach that prioritises behaviour change in the context of technologies that are being designed for behaviour change.

Traditional theories of psychology are recently being applied to understand the potential for using technology to persuade people to act and or think differently, with bespoke guidelines developed about how technologies should be designed and present information to users. This builds on the potential to use technology in TLC to achieve staff engagement instead of face to face engagement.

As the persuasive capacity of technology is a newly emergent field there is ongoing debate as to the correct terminology used and validity of the field. The scope for technologies to be used in behaviour change is not yet clearly defined although the literature indicates that it ranges from those used as support systems, to those active and central elements of the behaviour change process.

3.3 Technology and the User

The user in TLC might be defined in a number of ways. Understanding the individual user is complex and is often the focus in discussions regarding persuasive technologies, 'advances in online technology are making community and societal interactive technologies more common as well' (34). Therefore, it is not only individuals but a range of infinitely diverse groups who might be of focus (34, 50). Users might by targeted on different levels, such as:

- Intra individual level (individual alone)
- Inter individual level(dyads, couples, friends)
- Family level
- Group level

- Organisational level
- Community level
- Or societal level

(34)

Understanding the user's needs, interests, motivations, abilities, pre-existing attitudes, persistence of change that they experience, cultural factors, deep-seated attitudes, social anchors and perhaps even the whole personality, requires a thorough understanding of what happens in the information processing event, as well as understanding the roles of persuader, persuadee, message, channel, and context (37, 38). Individual differences in people may create variations in the effectiveness of different visualisation techniques and technologies as well, for example staff may have different levels of existing understanding of how to operate equipment and furnishings in the hospitals and the approach taken to technology utilisation in TLC must account for these differences (30, 45).

Ideally information in a project would identify with a wide demographic, in this case potentially all clinical staff in the NHS, would aim to deliver a broad and easy to understand set of messages, with more complex and specialist information encapsulated for those with a more in-depth understanding (27, 30).

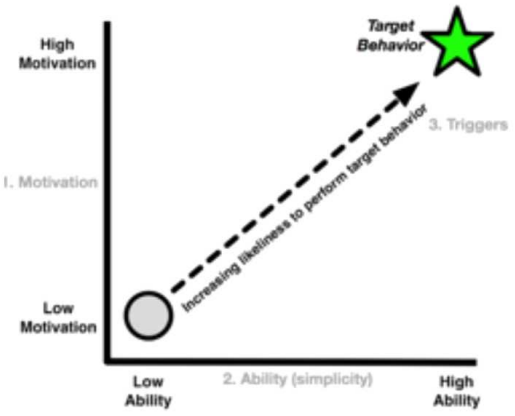
Stumbling blocks can arise when transferring technologies designed for an individual interaction to designing for groups (42). For example research shows that behaviour can be based on a need for some level of secrecy and privacy, a back stage area removed from the public performative spheres of life (42, 45).

Understanding the user can enable the communication of information that matters to them, to be presented in a way that they understand. Technologies used to produce infographics can tailor messages to the user and it follows, encourage more engaged staff as a result, reducing the risk of project failure and, building the strength of opportunity, for technology to be used as a cost effective alternative to face to face engagement.

3.4 Technology as part of the Process

Consolvo et al. (2009) discuss the transtheoretical model, which contains the stages that a person goes through when changing a problematic behaviour, pre-contemplation, contemplation, action and maintenance. This theory presents the idea of a process of change in one's internal attitudes. Literature that links energy saving and behaviour change is in agreement with this concept, that the information being delivered to a user should be viewed as part of a learning process, that leads to action, although in TLC the aim is geared towards engaging staff to act in a new way to build on their positive work caring for patients, rather than viewing their existing behaviour as problematic (38, 32).

In order to understand the process of behaviour change, J.B Fogg (a central figure in captology) maps out the motivation to act, connecting the user's internal processes with their subsequent actions, shown here (88).



This model demonstrates the process of achieving desired behaviours and two key variables, of motivation and ability, although it does not incorporate the idea that behaviours have to be maintained, as does the transtheoretical model. A staff engagement project should according to this model, satisfactorily address motivation and ability of users.

Research carried out into the potential of energy consumption information to be used to influence behaviours, has been coupled it with gamification, data viz and social media, to create a set of processes that a user encounters, that lead them through the processes that will end in energy saving behaviours, carried out in a student halls of residence (38, 31, 32). The results cautioned that relying predominantly on technologies to create behaviour change requires testing and calibration of methods in order to achieve success, and that buy in can often be low, is highly case specific and it is difficult to generalise findings.

The two kinds of process discussed above are the internal process of change that a person goes through leading to new attitudes and understanding and eventually sustained behaviours, and secondly the external processes which that person is part of. Technologies are also part of those external processes. The example above is based on the assumption that external processes can be

engineered to prompt behaviour change. This highlights that there may be risks of failure when using technology alone to achieve staff engagement. TLC is similar as in both cases users do not pay for the resources, however in TLC staff are incentivised by the prospect of improving patient care, one of their core job motivations.

3.5 Methods of Feedback

The method of feeding back information to users about their behaviour via technologies, is a central concern in the literature, debate has arisen about whether showing overtly negative images is detrimental (38, 40, 42). Consolvo et al. (2009) use overtly negative feedback to indicate unwanted behaviours and while Comber et al. (2013) use similar negative reinforcement, they caution that it must be carefully designed into systems. It is advised against entirely by Fan et al. (2012), who explain people can be deterred from using software if they believe it will give negative feedback.

Overtly positive feedback can be problematic as well, as users may feel they have achieved a significant amount and therefore should be able to relax their efforts in other areas (54). For example, in TLC, because staff care about patient wellbeing, switching off lights is overtly linked to patient rest and sleeping patterns that improve recovery times. Brewer et al. (2011) warn that this may lead people to become lax once they realise that they are achieving positive results through their new behaviour.

To give an example of a balanced approach, Fan et al. (2012) created a visualisation tool measuring step counts, which is incidentally the same measurement used by Consolvo et al. (2009), where a set of abstract artistic drawings change in size, getting smaller to indicate an unwanted drop in step counts rather than use overtly positive or negative images. Another successful trait of this project is that the meaning of the abstract images used are privatise, allowing more readily for public display, and avoiding 'injunctive norms', which is where the positive or negative feedback is presented in a group or in public, pressuring the user to fulfil social norms (40, 46, 47). Unobtrusiveness is a common theme in the design and evaluation strategy of many persuasive technologies, for example in the strategy of Consolvo et al. (2009), mentioned earlier (36, 37, 44).

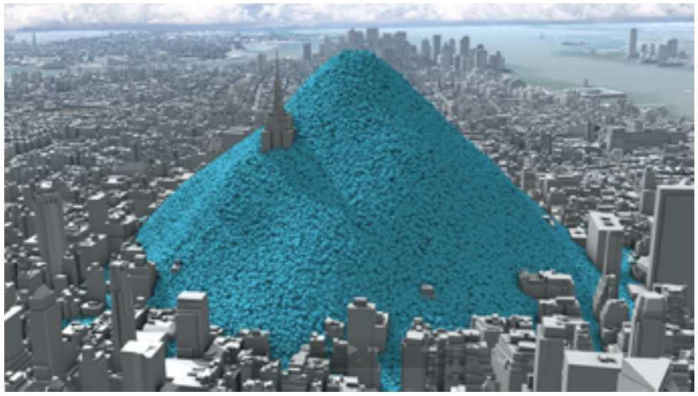
Brewer et al. (2011) focus on energy saving behaviours and suggest that a gain chart might be implemented to prevent injunctive behaviours, for example staff may not wish to close doors if it is

not the normal thing to do amongst their peers, however having been told the environmental gains they also then learn of the patient care gains.

Understanding the motivations of staff to engage in TLC and provide the best patient care that they can is important, however the guidance suggests that paired meaning can strengthen the probability of convincing staff to act in a desired way, and mitigate the risks such as when a positive action leads to a more relaxed attitude in other areas of patient care. It is also generally agreed that a conscious approach should be taken to the decision to use negative feedback of any kind.

3.6 Eco Feedback

There are a number of contemporary projects looking at how to visualise energy information in terms of carbon emissions, loosely termed eco feedback and also sometimes carbon visualisation. For example the image on the following page shows a visualisation of the carbon output for New York City. The image was produced by Carbon Visuals, who also incidentally produced more primitive but similar visuals showing the carbon output for the UK NHS Trust at UCLH against a 3D map of London (57).



This is a recent example of eco feedback, which by definition is used to communicate information about consumption of a material object (55, 56). Data on quantities of carbon dioxide gains a sensory quality against the city backdrop, giving a better understanding of the physical amount being emitted and can be used to compare differences, for example in cities or hospitals (57).

'Virtual reality and its novel applications to conventional planning problems, such as deciding upon resource allocation, may aid better informed decision making' (59). Eco feedback that incorporates

virtual reality could, it follows, be used to engage people in the goals of TLC and encourage better informed decision making as well.

While the potential of linking eco feedback with staff engagement exists, a literature search revealed that little work has been done so far linking ideas about how to communicate energy consumption information or carbon emissions to staff engagement (categorised in the search as data viz, behaviour change and carbon viz as it was felt to be more appropriate to the scope of this research than the term infographic).

In a project that links eco feedback and carbon visualisation techniques with behavioural change (particularly in non domestic buildings and organisations), the risk is highlighted that end users will lack a sense of ownership towards the data presented (60, 33, 34). Giving people feedback about their energy usage alone, translated into carbon consumption is perhaps not enough to persuade them to act, as they do not feel a personal sense of attachment to it. Grönvall and Verdezoto (2013) found that users care about their own personal information regardless of any other factors, therefore greater metrics on individual energy savings would logically improve buy in (61).

Another recommended method that has been applied specifically to translating information into energy saving behaviour is for an individual to declare their commitment to a specific task/s of saving energy (38). The literature about eco feedback is adapted from larger more established theories such as those that are used in behaviour change science, infographics, psychology and technology design. There is limited evidence to support the validity of this practice, however it provides a place from where practitioners can adapt and develop approaches that are best suited to dealing with engaging staff with TLC.

Another complication is that energy is an abstract concept and inherently problematic to attribute to actions or represent accurately. It is often represented in an abstract way, for example the operational time of an electrical appliance like a light bulb, or as the embodied carbon dioxide that is produced through its' use, visualised as balloons in the earlier example. TLC is faced with these challenges also, using the message of patient care as a way to translate energy savings into something meaningful. This is an innovative approach to eco feedback.

3.7 Testing the literature

The principals and guidance found in the *3. Literature Review* were drawn out and are summarised into key points for each section. It became apparent that the summary points fall into one of the three categories developed by Tuft about infographics: art (or termed here *aesthetic* as it alludes to the general choice of portraying information), the *user* and the *data*. Although Tufte was describing different kinds of infographics, the categories are broad enough to encapsulate the themes found in the *3. Literature Review*. Those points that do not fall into one of the three categories fit easily under the chosen fourth heading of *process*, defined as the influence that technology can have on the surrounding processes in TLC and how technology is contextualised within processes in a way that supports the goal of staff engagement.

There are also a number of generic benefits of utilising technology, these are listed below:

Automation of manual processes - to save time and cost
Recording information - to be used as a research base in, for example, funding bids
Reporting on outcomes - representing information in an easier to read format
Tailoring information - to appeal to the individual
Create a standard format - to implement the project and aid monitoring and reporting
Delivery of messages and information - to engage staff

These also fit easily into one of the four categories, as this table demonstrates:

Sec.	**Summary of the discussion from each section of the *3. Literature Review***	**Link to TLC**	**Additional generic benefit**		**Category**
3.1	How to use represent information in a visual way that informs people of the goals of TLC.	Visual representation of TLC	Reporting on outcomes Delivery of messages and information	Design the representation of information	Art/ aesthetic
3.2	How technologies can be used to influence and change the psychology of staff in TLC.	Influence the staff in TLC		Influence the staff in TLC	The user
3.3	How to identify and define the staff and make the individual feel personally engaged in a wider issues presented in TLC.	Understand the staff	Tailoring information	Understanding the staff and tailoring information to them.	The user
3.4	How to balance positive or negative feedback to encourage staff to engage in TLC.	Reinforcing staff behaviour		Reinforcing staff behaviour	The user

Sec.	Summary of the discussion from each section of the *3. Literature Review*	Link to TLC	Additional generic benefit		Category
3.5	How to take the existing literature and apply it to help reduce energy as it is still largely unexplored.	Understanding the surrounding processes in TLC	Recording information Create a standard format	Understanding the surrounding processes (especially standardise-able and used to record outcomes).	Process
3.6	How to apply theory to real world problems, taking into account the surrounding processes.	Using eco feedback		Use eco feedback	Data
			Automation of manual processes (save time and cost).		Process

These categories will be used later as a framework of analysing TLC. The immediate observation made possible by this exercise is that there is a lack of discussion in the literature about how to account for the processes involved in a staff engagement campaign when considering technology utilisation. Further, the outcomes of TLC are also not represented in the literature, although they relate to each of the categories. Outcomes are included in the *4. Results* section as a separate section.

4

Methodology

The methodology is based on the motivations of the research, looking for ways to achieve an understanding of technologies utilised to achieve staff engagement. This involves understanding TLC, coupled with insights gained from the literature.

4.1 Research Outline

Goal	Deadline
Make connections with project partners GAP, Barts	20.12.13
Staff engagement hospital visit	28.02.14
Scoping for Screen installation	01.03.14
Launch appeal for new screens to be installed	15.03.15
Initial Literature search and review	28.03.14
Write business case for screen installation	17.06.14
Second Literature search and review	05.05.14
In-depth interview project leaders	01.08.14
Transcribe interviews	07.08.14
Operational analysis and Process Map	10.08.14
Existing model analysis	10.08.14
Development of staff technology engagement	10.08.14
Write up report	15.08.14
Drafting	31.09.14
Submit	01.09.14

4.2 Complexity in the Research

The models and theories mentioned in the *3. Literature Review* are insightful and well considered approaches, however a seminal historical theory by Churchman (1967) highlights a common issue, that one can never truly solve the 'wicked problems' created in the course of tackling the complexities of real life (76, 77).

Churchman warns that the potential array of methods used to 'tame' real life problems are wide and that they risk partially solving a wicked problem and presenting it as a solved whole, perhaps even creating further problems that have not been accounted for (76).

Rittel and Webber (1973) offered prevailing guidance about how to tackle wicked problems (67). They emphasise that parts of a wicked problem can be broken down into 'nodes', connected up together as part of a larger, less certain whole. The smaller areas of focus encapsulated as nodes, can be arranged in relation to each other, in a hierarchical way. One can progress through these nodes, which make up a 'problem set', starting with the easier to define and solve, lower down 'nodes' and working up progressively.

Solving wicked problems is perhaps inherently impossible, and the effort itself is the measurable achievement. For example, this research project is not able to account for or solve all the uncertainties of TLC, to give an extreme but not uncommon example, TLC might fail if a hospital is announced to be shutting down.

Initiatives to engage staff might also overlook critical factors that influence, by attempting to carve out and solve parts of a more complex and larger whole. Designing a technology to address one element of a larger set of organisational processes, for example the measurement of specific energy saving behaviours or particular energy metering systems, might not be applicable in another hospital or area (54, 77). This problem with technologies is called 'lockin'. To give an example, an application developed for staff to read stories about TLC on their i-phones, might help them engage in the project, however some may not have i-phones or be able to use them at work, or when a new

model of i-phone is released they will have to download and learn the new settings of the application. A way to partially mitigate lockin is by providing training for users, to become acclimatised to using the correct technology in the desired way (45).

4.3 Understanding the Project

To understand TLC, and bridge the gap between the realities of technology use in the project and the ideas presented in the literature, a qualitative approach was taken. First, the literature was evaluated to find methods appropriate for the aims of this research, the most closely aligned approach with the aims of this research was found to be a toolkit called Design with Intent (DwI). DwI is one of the few available toolkits which incorporates differing methods of understanding the life cycle of a technology from conception to end use, drawing upon diverse theories such as product and software design to advertising (74, 75).

DwI was considered as a guide for evaluating TLC as it factors in elements of the eventual use of technologies such as positioning and usability, however it does not discuss the importance of understanding the operational processes or anticipated outcomes of the scenarios in which technologies are used.

To understand the operational processes and outcomes of the project, firstly, the project delivery team were joined for three days of staff engagement in different hospitals, taking part as a member of the team. This gave a deeper understanding of how TLC is implemented at an operational level.

Experience in the hospitals made it clear how important face to face engagement is, in the staff engagement campaign at present. Ongoing relationships between the delivery team and hospital staff entices engagement in TLC, allowing for an understanding of the needs of hospital staff, with the ability to identify opportunities to engage with staff and those more interested in TLC, as well as establishing permissions and trust from ward managers. Without this insight, the danger might be to assume that technologies can simply replace face to face staff engagement, which the literature supports, may be complex and difficult to achieve.

4.4 Interviews

Two informal in-depth interviews were conducted with the key leaders of TLC. The experience working with staff engagement teams informed the kinds of questions chosen in the interview. The results were evaluated in light of the four categories from the colour coded table in the *3. Literature Review*, marked with corresponding colours to highlight areas of discussion. The interview questions and transcriptions are detailed in appendix A and B.

This process enabled a detailed evaluation of the interviews and a better understanding of TLC from a managerial perspective. The results also informed a desktop analysis of the processes involved in TLC, including differences in implementation at different sites, as well as a portrayal of the outcomes and detailed evaluation of the technologies used.

The methodology of the interviews followed Loflands' approach. From this technique, the following guide was developed:

Ask difficult and challenging questions last.
Think from the perspective of the other person when deciding questions.
What are global concerns?
What is my bias?
Use probes to find out more
Detail the interviewee characteristics Avoid leading questions
Tape interviews
Use one guide note sheet per person
(87)

Having conducted the interviews, the informal in-depth approach was found to be highly successful in gaining an understanding of TLC. There is little publicly available information about how TLC came about or was implemented and therefore the interviews revealed aspects completely unknown previously, that it would have been impossible to plan questions for, in a more structured interview and without the experience working with the TLC team.

An addition was made to the interview technique, to show interviewees the guide sheet with questions before the interview. On reflection however, this limited the interviewers ability to adapt to new information presented during the interview or to follow up with more in depth discussions on those points. It was also difficult not to intervene with leading questions, which prevent the interviewee from giving their own account.

Informal discussions were also held with commercial managers working outside of TLC, to gain insight into the way that projects are structured in a generic sense. This made it possible to view TLC as a set of processes, drawn up into a map in section *5. Results.*

4.5 Observational Studies

Observational studies were conducted in the hospitals, to find opportunities where hardware technologies can be installed to deliver TLC messages, and might be optimally placed for staff to view them. This has led to the potential for new ways of using technology to support TLC and will be discussed in the *6.2 Future Work* section. The Future Work for this project draws upon theories of space syntax and also from informal discussions with colleagues, to understand not only peer research and reveal related theoretical landscapes, but also the practicalities of installing new technologies.

4.6 Ethics

Guidance on any potential ethical issues was provided by the academic supervisor Michael Pitt. Permission to go into the hospital environment at Barts was granted by sustainability manager Fiona Daly.

While objectivity was sought at all times, this study is biased as it is conducted from the perspective of those delivering TLC. Also, the parties mentioned in this research have been given the opportunity to comment on this research and request for any sensitive material to be left out, although nothing was omitted in this report.

5

Results

From the colour coded table presented in the *3. Literature Review*, it is clear that the two categories discussed most in the *3. Literature Review,* are *process* and *the user*. Supporting this focus, appendix A and B show that the project management team also focus most on *process* and *the user* throughout the interviews.

The interviews also revealed that there are four possible users, rather than one uniform group:

User 1: The staff, receiving information about TLC and being asked to engage
User 2: The patients, being impacted by the way that the clinical areas are managed by staff
User 3: Those delivering TLC
User 4: The governing bodies who control TLC

Patient users were not an active area of focus in this research as TLC is geared towards engaging staff specifically rather than patients, although they were discussed in the interviews.

The red category a*esthetic*, was raised infrequently in the interviews. This indicates that the opportunity to use visualisations of information to aid delivery of TLC might be an underutilised opportunity. The *3. Literature Review* suggested that this can be an effective method of engaging staff, if done in a considered way and with room to adjust visualisations to the users after initial testing.

5.1 TLC Outcomes

From being immersed in TLC project delivery and interviewing key figures, a number of positive outcomes emerged to taking the TLC actions, Turn off equipment, Lights out and Close doors.

Turn off equipment: Using the scoping phase of TLC in each new hospital to find unique opportunities is key, to ensure that benefits are correctly identified, measured and quantified (Appendix A). One-off substantial energy savings from switching off large pieces of medical equipment were discovered in this process. Small appliances can also be switched off to create savings.

Lights out: Switching off lights allows for a more restful environment for patients to sleep as well as improved access to natural light which is good for recovery (62). In 24 hour wards for example quiet time was introduced and lights turned off. This also created time for staff to write up notes.

Close doors: The temperatures in hospitals are advised upon by medical experts and regulated by estates teams based on the kind of treatment that patients receive, for example, maternity wards are kept at a higher temperature. Closing doors is a way to regulate temperature. This also supports building control technologies, heating ventilation and air conditioning (HVAC) systems and automated thermostatic control devices.

Closing doors also improves safety, the dignity and security of patients. Leaving rooms open might also encourage opportunistic crime.

A more recent understanding of the motivations behind TLC, strengthened by this research, is that using technologies in an energy saving way can positively impact staff wellbeing. TLC project shareholders set forth the idea that switching off computers and appliances might help staff 'power down', switch off mentally from the working day and improve work life balance. This research found that this is not yet substantiated, however current work being done to improve staff wellbeing by research communities as well as the British government and the European Union, centred upon the ideologies of mindfulness, advises that by engaging with their working environment and taking

control of their surroundings, staff can improve their wellbeing in the workplace[1] (63, 64, 65, 66, 67, 68, 69, 70, 71, 71b, 71c, 71d).

Improvements to the understanding of the social benefits of TLC are planned, to quantify patient recovery times and investigate potential correlations to the TLC actions.

Understanding and reflecting the outcomes of TLC in the way that technologies are used, is crucial to the project success, with relevant benefits communicated in a dynamic way to the right stakeholders in the project, to strengthen more senior level engagement and to increase savings (Appendix A). This is a broad enough statement to apply to almost any project. To elaborate, patient care is at the core of TLC, and while it is likely to be a stronger motivating factor for users 1 and 2, patients and clinical groups, it is a central concern for all users.

Misinterpreting the significance of the project outcomes and using technologies ineffectively could lead to a number of severe problems. Firstly, it may have resulted in worse patient care, for example to turning off the wrong medical equipment, setting room temperatures too cold for patients to recover in, with a view to saving energy. Secondly, the messages of TLC might have been un-engaging for clinical staff, centred upon economic sustainability, such as the potential costs saving or improved CRC position, which has no tangible impact upon staff.

[1] The meaning and significance of mindfulness is not elaborated upon here due to constraints in the length of this report, however a research summary is available regarding this point. Please email l.campbell.12@ucl.ac.uk.

5.2 Technologies in TLC

The technologies used in TLC incorporate all four categories developed from the *3. LiteratureReview*, discussed in the following table.

Technology	Usage	Function	Category
Clinical softwares	Machines used in medical treatment Guides provided on energy use Efficient use reduces energy consumption	Tool	
Staff news letters and E-bulletins	Communicate with staff about TLC NHS staff reading and reporting on working life	Media	
Scheider and MICAD (smart meter interfaces)	Engineering staff use for reporting Collecting data on energy use Operated on electrical equipment Prove if behaviour change impacts energy consumption	Tool	
Engineering help desk reports	Staff report problems with the building Engineering respond to reports Monitoring behaviour Give feedback on building user satisfaction	Tool	
Administration: word processing, email, spreadsheets, internet	Not available to all staff such as portering staff	Tool	
Dashboard	Display project outcomes for TLC Can tailor information to different users	Media	
Data collection software	Carryout ward checks about TLC actions (further consideration about who will carry out checks) Faster than manual checks Measures can be reported back to different users	Tool	
Visualisation about TLC	Deliver messages about the outcomes of TLC Displayed in different areas	Media	
Social platform	Capturing feedback Giving a voice to staff and patients	Media	

Note: The blue indicates technologies still being developed.

The function category of the table above is taken from Fogg in Atkinson (2006), who classify interactive technologies (the term 'interactive' can mean a diverse number of things) as firstly tools, secondly media, enriching their conceptual schemata of the world and lastly as social actors, persuading people to act (35, 89). The interviews and immersive experience delivering TLC

revealed that technology is not yet being used in TLC as a social actor. Social action was achieved through face to face engagement between NHS staff and GAP. The table also confirms a lack of focus on aesthetic.

The categories column (developed in the *3. Literature Review* and colour coded) show the primary area that each technology fits into, although in reality the technologies mentioned overlap with other categories as well.

5.3 Desktop Analysis of Processes

This next section outlines the processes involved in TLC. First, the partners involved in TLC must be clarified (Appendix A and B) The contributors of TLC form part of the governance of the project and shaped the aims and processes involved in delivery as well.

- Global Action Plan (GAP) are partners with Barts, they are the project delivery team and engage staff on the ground in TLC.
- Carbon Culture is a partner of GAP, who develop bespoke softwares that support TLC, indicated in blue in *5.2 Technologies in TLC*.
- Skanska are partners with Barts who provide construction, development and infrastructure processes to Barts. They provided £25,000 of the £95,000 for the initial stage of TLC (Appendix A).
- GE provided a further £20,000 towards the initial cost of TLC as well as specialist advice about medical equipment and its ability to be switched off . Barts provided £45,000. The total sum was paid to GAP for their work.
- Queen Margaret University London (QMUL) conducted a pilot study of TLC for four months with GAP, this research helped secure continued funding from the Department of Health and aided staff engagement.
- The Department of Health provided funds after the initial phase of TLC, from money set aside to help NHS trusts reduce their energy bills. The department of health's elective measurement verification (M and V) partner is Cambridge university.

A core motivation of TLC is to achieve efficiencies with short term payback, to repay the funds provided by partners, although this may evolve to incorporate payback over the long term as TLC

becomes a proven success. Repeated evaluations of a growing number of hospitals where TLC is implemented will build stronger cost analysis to enable this transition.

The way in which TLC has been delivered is effective, however, face to face engagement is not only costly, but labour intensive and time consuming. In Barts for example, the trust has grown from an already substantial 8,000 staff across three sites to 15,000 members of staff across five sites (Appendix A; Appendix B). GAP engaged members of staff in each area of Barts to promote the objectives of TLC. They visit areas three times, which is a commonly agreed number in memory training techniques and confirmed by GAP staff in TLC.

GAP use a generic project management toolkit to realise TLC, the four stages are to scope, design, deliver and evaluate.

During the scoping stage of TLC, GAP staff held focus groups to see firstly which actions can be agreed by staff. Visits and or communications material such as posters to support engagement, can then be planned and implemented.

TLC also had many individual sites for which GAP created smaller check cycles. Each hospital has its own project management package, and each ward is then graded on whether it carries out the TLC actions. A spreadsheet was kept about the visits made by GAP, detailing:

The time
Where they were going
Who they spoke to
A comment of what was discussed
An observation

Technology enhances the availability of this record. Before GAP staff go into an area they can pull up information collected and stored electronically, to see the history and make an appropriate approach.

Each area also has a list of champions or rather stakeholders who would be involved in TLC, repeatedly having conversations with GAP, usually they are in a position of responsibility, nicknamed a ‘keen green’ (someone with particular interest in sustainability and who wants to be involved) (Appendix B). Encouraging champions was achieved by rewarding them for the work

they do with praise and positive feedback.

In order to evaluate TLC, GAP carried out behaviour audits every three months, at the start of the project and continuously throughout, that focused on energy usage, recording the number of doors open and the number of lights and small appliances which were on over the course of the pilot study. It is hoped that these audits will continue indefinitely, however, they currently take 30 minutes per ward. It is estimated that with an electronic logging system the time per ward would drop to 10 minutes. This tool is currently being developed by Carbon Culture.

The focus of the QMUL study was upon patient experience, patient comfort and patient dignity and privacy (Appendix A). These were measured by baselining and then analysing complaints logs from help desks regarding issues such as thermal comfort, also conducting surveys with patients and staff. During this time baseline data was also collected in the form of smart meter readings of electricity usage.

Some of the reported gains in TLC are satisfying patients with less complaints, 1/3 Better sleep, 1/4 fewer privacy disruptions and improved patient experience (20; Appendix B).

Energy saving was calculated as a cost. For the overarching actions of turning off lights and small appliances and closing doors this was worked as an average and apportioned a value. Sub-metering that was used to measure this is not precise however. To understand the energy consumption of specific pieces of medical equipment, the guidance in the manuals which they came with, were used. Again, this is not the most accurate method as equipment often consumes energy differently than the way it is designed to.

GAP report to Cambridge University about the energy savings made in TLC, filling in an excel template every two to three months as well as volunteering an energy diary to elaborate on the progress made. This reporting mechanism is currently time consuming and does not capture the benefits of TLC in their entirety, Therefore GAP are providing a 20 page report as well. The final reporting for the Department of Health has already been submitted.

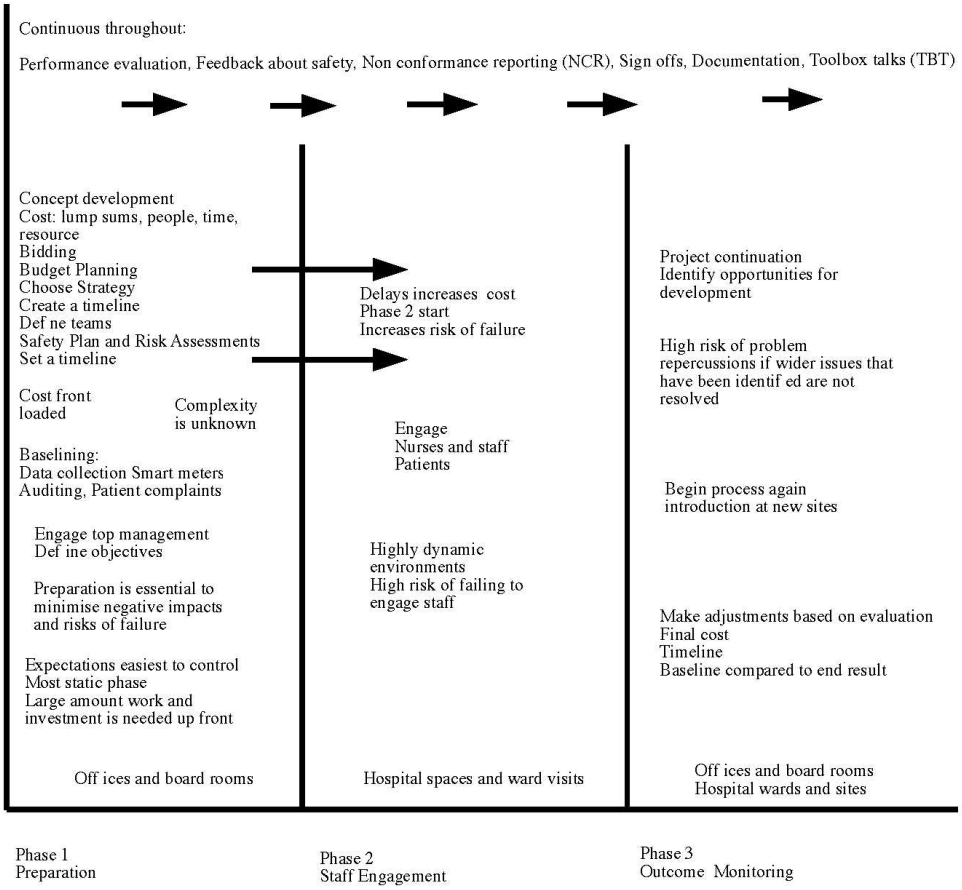
Also, weekly phone catch ups are held between Barts and GAP and GAP and Carbon Culture. Carbon culture also provide information about how many stories have been submitted and people signed up to the communications platform.

Every three months a more detailed review between Fiona and GAP takes place where there will be a powerpoint presentation with tables of what GAP achieved over that period, but that has not yet been standardised. This includes the number of staff engaged, the number of one two and three rating hospital areas.

There are two timelines for TLC, the Carbon Culture timeline for delivery of technology including uptake of the communications platform and a separate one for the project as a whole, neither of which have yet been shared with Barts. GAP's project management toolkit is a gantt chart which is filled in as a toolkit's action plan.

5.4 Process Map

In order to understand the generic processes in TLC better the process map on the following page was developed.



Much of the generic processes in TLC happen at the start and end of implementation. There are also a number of standardisable processes that happen continually throughout. The staff engagement phase is the least standardisable, happening in unpredictable ward environments.

The *3. Literature Review* suggests there are many ways in which technologies can support *Phase 2*, helping deliver during the high risk phase of operation TLC. Using carefully designed visuals to deliver supportive messages about the advantages of TLC can reinforce messages and reduce the risk of failure, as well as potentially mitigate costs of face to face to face engagement, although this, it is suggested, takes careful consideration and several iterations of designing visuals and supporting methods of delivery.

5.5 Differences in Implementation

Differences exist in the sites where TLC was launched. Face to face engagement makes it easy to detect these differences, identifying underlying barriers to engagement.

GAP differentiate wards based on how easy the staff are to engage, putting effort into understanding what are the barriers in wards where staff have only partially engaged with the TLC actions. It is crucial that any barriers that can be, are removed. In one instance the air conditioning was broken and the weather was hot, so the doors were kept open to prevent deterioration of the drug stores while at the same time putting pressure on cooling systems in other areas. The issue was then reported to engineering and doors can be closed (Appendix B).

There also exists variation between the different treatment areas of the hospitals. Staff in operating theatres are easy to engage for example, perhaps due to the highly standardised nature of these spaces which have easy to follow schedules, in contrast to accident and emergency areas where GAP chose not to engage due to the highly unpredictable nature of these areas.

At Mile End Hospital where patient care is psychiatric or for the elderly, staff have a more time to talk, which makes it easier to engage with them. Other feedback that affected engagement was that some wards are better managed or better resourced making it easier to talk to staff on those wards (Appendix B) .

The different hospital trusts also alter the nature of TLC. Barts is one of the largest NHS Trusts, and also has the largest carbon footprint in the NHS (57, 72). Barts trust was merging during the time TLC was first launched, from the Royal London University Hospital and St Bartholomew's Hospital, to include Newham University Hospital, Mile End Hospital, Whipps Cross University Hospital and The London Chest Hospital.

Barts has been going through a large merger and therefore there are lots of other changes going on at the same time as TLC and other pre-existing initiatives in different hospitals making it difficult to work out where operation TLC fits in. To give an example, the 'Because We Care' campaign that followed the Care Quality Commission (CQC) audit has now faded and another campaign 'Changing Lives' is merged into either of these and they subsequently change, it makes embedding

TLC in the trust difficult.

Frimly Park Hospital Trust is much smaller than Barts, mainly comprised of a single hospital with several smaller outpatient and diagnostic service sites (73). Frimly also has a more stable structure with continuous leadership from the same director over a considerable length of time. The trust is located in a more rural area than Barts and serves a larger but less densely populated area.

At Frimly, face to face staff engagement was more successful. Senior nurses agreed upon key actions that GAP staff would achieve, that they wanted to improve patient feedback for privacy at night for example and focused on this specifically during delivery. GAP staff also reported Frimly as a more 'friendly' hospital. There may be a number of reasons for this, the detailed records of face to face engagements would be invaluable to understanding this in more detail

A more stable management structure allowed senior nurses to take control of their goals for their wards, creating a more focused set of engagements that were easier for staff to engage in. In the midst of a merger, and being in a busy urban environment, Barts staff are likely to be under more pressure, with less resources and less stability in their management that would naturally create a lack of leadership, making them less able to engage with TLC.

These variations in sites should factor in to how technology is utilised, balanced with face to face engagement.

6.

Discussion

6.1 Discussion

Technologies being utilised by user group 3 (those delivering TLC) to assist them in carrying out standardised processes such as sending emails, recording project sign offs are being used to good effect. The process map in *4. Results*, outlined key areas where TLC is standardisable and can be supported by technologies in this way.

The three month report that goes to Fiona at Barts will be standardised through the use of technology, developed by Carbon Culture as a data viz dashboard containing the relevant information. Infographics methods are ideal for reporting back to stakeholders about relevant information in easy to grasp ways. They might be used to report back to the staff being asked to carryout TLC actions, or to pitch to decision makers in hospitals, interested in launching TLC. To support this, good working relationships with marketing and communications teams is crucial, as they can offer structured insight into the necessary format of messages depending on each organisation, as well as with Carbon Culture who are producing much of the infographics in TLC (31, 32).

Records about the different wards and hospitals are a valuable indication to management as to the hospital's performance, highlighting for example problems with a lack of resources or individual managers or teams. Technologies can aid the effective communication of such information to the relevant managers, storing and sharing information in easy to read formats. This is similar to the way that GAP staff successfully use electronic records, before they go into an area, they can pull up information collected and stored electronically, to see the history and make an appropriate approach to staff engagement based upon it.

Technology can cut down the labour intensity of TLC, for example reducing the time taken for energy usage audits or communicating information to staff via data visualisations.

Better design of the reporting spreadsheets by GAP to Cambridge university could improve project delivery, by making an easier to use document that encapsulates more information than energy usage alone. The reporting is not compatible with the energy monitoring softwares that are used in TLC to quantify usage (this is an example of lockin). If these were compatible the reporting done to Cambridge might be automated rather than manually input.

The way that energy is currently quantified could be more accurate also. A benefit of energy monitoring systems in place, such as Schneider and MICAD, is that they improve accuracy of information about energy consumption that provides the governing bodies with better feedback about TLC, and further validates the idea that improving patient care can inherently lower energy consumption in the hospital where TLC is implemented. There is room for improved accuracy however, this would be facilitated by the engineering department of a given hospital. Equipment might be measured for actual use rather than rely on the standardised information provided in the manuals for example. The energy audits also provide improved accuracy.

The timeline for Carbon Culture to deliver technologies is not currently streamlined to the project delivery of the rest of TLC. This would, it seems natural, be a contributing factor to the low uptake of the bespoke communication platform that Carbon Culture have developed. GAP can use their existing project management processes, supported by computerised administration packages such as gantt charts and shared project sign off sheets stored electronically (and available for remote access), to rectify this problem.

Another element that might aid clear project delivery would be to develop an organisational chart that other hospitals can follow, to understand a range of the key roles in TLC and use as a template to fill in and adapt for each time TLC is implemented. A representation of the roles and responsibilities might be created using infographics tools and using guidance provided in the theory.

The current method of reinforcing face to face engagements are limited, one example is that in the absence of negative feedback (a reduction in patient complaints), hospital staff are motivated to continue taking TLC actions and realise the positive impact that they are having on their patients wellbeing. The engineering help desk electronically monitors and logs this information so that the

benefits can be formally reported. Creating a more comfortable working environment with better regulated temperatures that is more peaceful is also perhaps a motivating factor for staff to perform TLC actions.

In comparison, the communications platform would provide overtly positive feedback to staff about TLC, to deliver messages about the successes of TLC. Supporting media is currently used to deliver positive feedback with limited impact, improvement to the utilisation of these technologies will hopefully encourage staff to take TLC actions, the impact should however be monitored, given the debate presented in *3.5 Methods of Feedback*.

6.2 Future Work

This next section discusses the results of a formal observational study conducted in the course of this research, on how to utilise hardware technologies to deliver the messages of TLC in public spaces.

6.3 Canteens and Cafes

A potential area of development that was explored was the opportunity to use visualisations about the benefits and successes of TLC to communicate with NHS stakeholders, delivering messages in the catering spaces of the hospitals using display screens. Part of this research was to investigate how these messages can be displayed. In Barts the opportunity arose to install touch points in hospital canteen spaces, predominantly in the form of display screens.

Displaying positive messages in the catering spaces might be one of the methods of engaging staff in TLC. It can support or replace the positive work done by face to face engagements, in contrast to other stimuli such as dropping numbers of complaints from patients. The idea to use screens builds upon the overtly positive messages of face to face engagement in TLC, however they may be unnoticed by staff or be forgotten when staff go back to their wards, therefore they are not likely to prompt engagement when used alone.

The area of research used to build a template from where to evaluate the complex environments into

which the screens would be introduced was space syntax. Space syntax is a term used to describe spaces in architecture, how people move within them and their social significance given their structural properties (80, 44, 81, 82, 83, 84, 85).

Methods of observation used in space syntax were applied in each of the Barts hospitals, to decide where screens might be optimally placed in order for staff to see information regarding operation TLC. Part of this research was also to write a formal report to the governance team of TLC, as well as the funding application for screens which is currently being processed[2]. This entailed, firstly an initial visit to Newham University hospital with GAP and Carbon Culture, secondly a detailed set of observations at each site using techniques from space syntax, thirdly an investigation into the feasibility of the placement options (discussed with Healthcare Messaging, the Company who supply and install all screens in the trust), then writing a guideline document and finally writing a business case for funding.

Further research about the success of the screens is planned once they are installed, to build up a set of advice about the considered placement of TLC messages in the future.

6.4 Accident and Emergency

One potential new area where technology can be installed to enhance the delivery of messages in TLC is in a clinical area not currently included in TLC, Accident and Emergency (A&E). A recent study was done about BCSS (mentioned in *3.2 Technology that Persuades*) and healthcare environments, specifically tackling this area. The reason TLC has not yet sought to engage with A&E staff is that staff there don't have time to talk to us, it's not practical to go in there, it doesn't matter what hospital it is.' (Appendix B). As face to face engagement is not a feasible option, technology presents an alternative tool for engaging with staff.

This idea is based on a piece of existing research found by conducting informal interviews with academic staff at UCL, including Paul Marshal. In their research project, Paul Marshal et al. (2011)

[2] This research included a detailed guideline document advising on the placement of screens as well as a business case for the screens which is under review. Please contact l.campbell.12@ucl.ac.uk for a copy of these reports as the word limit of this report prevents their inclusion. One of the next steps following this research will be to install and evaluate the use of the screens, choosing the appropriate method of evaluation based on current research in the area (44).

work towards engaging healthcare staff in the A & E department of a hospital using 'situated interactive displays', to obtain feedback about how they might wish to see their working environment changed (49). Marshal et al. 'situate' the screens using theories of space syntax. The aim is to create a working environment that reduces staff stress levels and increases restorative opportunities, using staff feedback about the space to inform the design. This is closely linked to TLC, which aims to create a better environment for both staff and patients and a similar approach in A &E areas could capitalise on the work already done in this research, to extend the areas in which TLC can engage staff.

6.5 Measuring Success

Measuring the success of technology utilisation in TLC, given the above suggestions, might draw on similar metrics as those used in existing studies about TLC. The established measures in TLC were discussed in *5.3 Desktop Analysis of Processes*, they focus on patient satisfaction (established in the QMUL study) and energy consumption (calculated, measured and recorded by GAP). Other measurements are also required, and suggestions made below, to verify the impact of different suggestions for technology utilisation:

Instance where a technology utilisation change was made	**Didn't have change**	**Measure of impact**
Screens in Canteens	No screens in Canteens	Established metrics
Screens in A&E	No screens in A&E	Established metrics
Tablets with ward information	No tablets with ward information	Established metrics
The platform is present	The platform is absent	Established metrics
Staff engagement with dashboard	Staff engagement without dashboard	Established metrics
Reporting problems identified in TLC to decision makers	Not reporting problems identified in TLC to decision makers	Resolved engineering issues and staff satisfaction surveys
Old spreadsheet	Redesigned spreadsheet	Survey on ease of use & time to fill in spreadsheet
Predicted energy usage given on specialist equipment	Actual energy usage on specialist equipment tested with specialist equipment.	Compare to see if they are different.
Manual energy consumption audits, calculated in KwH	MICAD and Scheinder records of energy consumption	Compare to see if they are different
Technology delivery timelines are streamlined with TLC project timeline	Technology delivery timelines are not streamlined with TLC project timeline	Uptake of the carbon culture platform

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Instance where a technology utilisation change was made	Didn't have change	Measure of impact
Project delivery team's understanding of TLC having seen an organisational chart	Project delivery team's understanding of TLC not having seen the chart	Questionare
Manual energy audit	Electronic energy audit	Time to fill in audit
Pitches for new work with dashboard	Pitches for new work without dashboard	Work won

Note: established metrics are those already in place and discussed in *5.3 Desktop Analysis of Processes*.

The measurements suggested in the table above would have to be analysed in more rigorously, to ascertain the validity of the suggestions made.

6.6 Limitations of the Research

This research could not analyse the aesthetic representation of information in TLC as infographics are only just being developed by Carbon Visuals and not yet operationalised, also Carbon Culture being unavailable to discuss their visuals in interview.

The interviewees represented in this research are key decision makers in TLC, however the research would have benefitted from a larger sample size. Other people who would have been interesting to include would be a key member of staff from Carbon Culture, more members of the GAP team, hospital staff and patients. This compensated for by taking part in immersive experiences working to deliver TLC.

Although work has been done in the course of this project, to understand how to operationalise bespoke technologies and understand the surrounding processes, opportunities and risks, they are not yet completely ready for implementation in TLC and therefore findings are largely speculative.

6.7 Generalisability

The findings of this study are generalisable to other instances where TLC is being implemented. This research is only representative of a small number of hospital sites and therefore the generalisability is still limited and does not extend to non clinical sights. Clinical areas require careful understanding of the medical technologies being used, therefore present a unique environment, and the technology requirements of TLC may differ considerably from, for example a student residency.

7

Conclusion

This research reviewed the utilisation of technology to achieve staff engagement in light of a longitudinal study about TLC and related theories from the literature, to find opportunities for development. TLC will increasingly become a replicable model for the wider NHS to implement and rely on more varied forms of staff engagement, including in some cases an increased utilisation of technology. Technology can aid TLC in its' core aims in all cases and is already doing so to some extent.

A methodology was adapted from existing theories and informal, in depth interviews were conducted, as well as working closely with GAP, taking part in the delivery of TLC and conducting formal observational studies. From the results of this research, the following conclusions can be made.

To understand how technologies support the core aims of TLC, it is crucial to identify the different users involved. The processes and outcomes involved in TLC also play a crucial role in determining how technology is used although they're not central in the literature.

The processes involved in TLC were discussed in *5. Results*. The kinds of everyday technologies used to support these processes include spreadsheets, email, news bulletins etc. The supporting literature however focuses heavily on specialised technologies such as personal informatics and complex monitoring softwares, while the readily available, commercially used technologies that are part of the everyday life of many organisations are less of a focus. Everyday technologies are indispensable to a significant set of processes involved in TLC. Technologies such as these support communications with the relevant departments and shareholders ensuring clear project execution.

There is active discussion of sophisticated technologies that communicate information in the form of infographics and captology, as well as a range of connected theories, highlighting the needs of the users, the complexities of choosing an aesthetic and of using data sets and supporting statistical

analysis to draw meaning, as well as discussions regarding how best to persuade people to change their behaviours.

The guidance available also debates over positive and negative methods of feedback, bespoke technologies that specifically deal with behaviour change for reducing energy consumption. It is however challenging to account for the complexities of real life and difficult to apply ideas widely, as they are often regarding bespoke technology designs for individuals and or specific projects.

A particular area of development in TLC would be to support existing face to face engagement by placing infographics designed by Carbon Culture, into public spaces of the hospitals in strategic locations.

Existing theories often do not discuss the processes involved in delivering a project such as TLC, they do however focus on the process of changing people's behaviours. These internal processes of might be mapped onto the external operational processes in a project such as TLC, however the limited number of related examples of this have not been reliable. Particularly in cases where face to face engagement is not used at all, this lack of understanding would perhaps prove problematic.

Of the suggested changes to the utilisation of technology, measuring success can, in some cases follow the existing measures set in place by GAP and QMUL, however some new measures would also be required, and might validate and refine the suggestions made in this research.

Some sites and areas in hospitals where TLC is launched might require more staff engagement than others. The scoping phase of TLC is invaluable to understanding these differences and can also be used to identify bespoke opportunities to engage staff, secures buy in from management and establishes clear goals and permissions to distribute TLC information and engage staff on specific actions that have been agreed upon.

Hospitals that are better staffed, managed or funded are likely to require less engagement. Other sites with low resources, more pressure on staff are those likely to require more face to face engagement however have less to spend. Technology can mitigate costs, however it is at the same time face to face methods that are invaluable to engagement, particularly in cases where hospital staff are already under a lot of pressure. The risk is that in some scenarios where face to face engagement is needed, it cannot be provided due to resource shortages, with technologies used to mitigate unsuccessfully.

Moving forwards, TLC must succeed in each case of implementation, in order to sustain its' success, as a commercial project being sold to other hospital trusts. Where the initial research base of TLC did not require consideration of how technologies are used, as the method used to engage staff relied on face to face engagement, this is changing and requires further consideration once technologies are ready to be introduced. This also presents a cost saving opportunity as, using technologies to engage staff is cheaper than face to face engagement.

In the future it is hoped that specialised technology, designed to support TLC will reduce costs and of implementation and time taken on the surrounding processes, making it a more accessible project to a wider range of hospitals. Some of this technology is already being planned by Carbon Culture and some further opportunities exist such as engaging in accident and emergency areas and canteens, using hardware technologies to deliver the Carbon Culture messages. This research has not 'solved' all the problems that will arise in the course of TLC in the future, it has however highlighted some of the key areas for development as well as the key theories and elements of TLC and strived for a more in depth understanding of TLC throughout.

8 Appendix A

Interview	31.07.14	Fiona Daly	Sustainability Manager	Barts Health NHS Trust

Guide Document: Question	Category
How did you become involved in TLC?	
What is the method of Feedback throughout TLC?	
Documentation of feedback	
What safety considerations were there in TLC?	
What teams are involved in TLC?	
What is the role of the different teams in TLC?	
What is the duration of TLC?	
What is the role of Carbon Culture?	
What are the reporting structures in TLC?	
What sign offs were needed for TLC?	
What is the governance of the project?	
What legal requirements do the project outcomes meet? Meeting project energy reductions.	
What are the efficiencies created in TLC?	
What does it mean to to create a collaborative model for sustainability in the NHS?	
What does it mean to show how partnerships can aid the NHS in achieving efficiency?	
How can to you demonstrate that behaviours make a material difference to efficiencies?	
How were the core aims of TLC achieved?	
What action creates the biggest cost saving?	
What processes were used in for example identifying the initiatives?	
How can you encourage new initiatives to be identified by other stakeholders?	
How was the project evaluated and defined and costed in order to report upwards to governing bodies?	
How was feedback gathered and analysed, then given to the management, what teams were involved?	
What were the costs of TLC: Lump sums, people costs times	
How was the impact monitored in term of cost and benefits - (staff patients environment)?	
What are the commercial gains of the project?	
Baseline: Data collection Smart meters Auditing, Patient complaints	
How do you view the carbon culture platform? As an education tool, a social platform, a persuader?	

Transcription:
Fiona, these are the questions that I'd like to ask. 'How did you become involved with TLC?' How did I become involved with it? 'How did the project start?'
The project started with a problem and a concept The problem was that at the time I was the only person looking after sustainability and at the time had about 8,000 staff across 3 sites and we'd done a whole load of stuff to do with sustainability, all head FM projects sort of thing bits of kit to save money. I really realised that there was a gap which was that while we had done all this good stuff, we hadn't engaged people in what we were doing: We had some really keen bods that were champions at the time but I couldn't give them the structure that they needed or the impetus that they needed in the volume of projects. So I went looking.
In my mind behaviour change was something that really frustrated me because companies would always tell me that they could save 5, 10% off the energy bill, but no one could show me how.
I'd always been of the opinion that whatever we do that involves people has to link somehow to our core business, so improving patient care.
When we went out looking for what we were going to do there was a very clear criteria but the main one was, I want evidence and research behind this project and we need to link it back to patient care.
Having done all of what you would do naturally, the footprint stuff, a desire to engage and link back to our core aims have had a long standing impact.
How was the project evaluated, and defined and costed in order to report upwards to the governing bodies that enabled it to happen. A few bodies came together, we know GAP, I'd been doing some work with them and liked their approach as they were very capable of engaging. We didn't have money at the time and so we had to go and ask people. Skanska and GE came back and said that they'd part fund it. On the back of that everyone wanted something out of it so criteria were built around that. There were four main criteria really, save money on carbon through energy, to prove that acting in an environmentally responsible way saved energy or not, improved patient experience or not, and to prove that together we could do more to create a collaborative model and replicate it too because time and time again projects suffer from not doing that. 'What were the collaborations and partnerships that together could be delivered but not individually?' It was through good working relationships that the partnerships came about.

Transcription:
What were their individual gains? For both GE and Skanska it was about continuing to be associated with Barts and for them to be helping us, because they are building our buildings and in our long term plan. GE are very integrated in health care and very interested in the behaviour side from a technology point of view. So they have a massive g-tech department and they look at integrated technology systems but they require people to behave differently. For both companies it was a good message to have. And for GAP they're whole purpose was to save carbon and that's what they were doing. I think that for them, putting some research behind it and having something that was really tangible that they could use in another application really helped them.
The second part of the research was evaluated by QMUL so that was a big piece around the patient experience, baselining the patient experience then we had to measure it half way through, and at the end. We had to keep some wards that we did nothing with because we had to have comparable data and make sure that those wards were like for like and almost building a line round an area and saying these are the people that we are going to focus on this is what we're going to do. It becomes harder over time because the more we are embedded with TLC and people start to work across sites you don't get that boarder of things.
So we won't get that opportunity again and now it's across all sites and everybody's doing it and that's exactly how it should be but it's interesting to see those sorts of comparisons.
Just quickly, was the trail was that duration like six months or like one month?' They were engaged probably for, the trial was 4 months, there was obviously some set period for the trial so they were engaged for those entire four months so they did the baselining and they did the midpoint and then they did the end point, and they spent some time evaluating, making, testing the research and making sure the data was correct because they're putting their name to the research. And so and we used that, when we put the case study out for the NHS, so we used their data and their research, so that's now research that's available to the, for other people to use.
So some of the measurements for example cost… 'Go on' I was going to say ... back and forth... (Interviewer encourage Fiona to talk). So the patient experience was measured by two things which were sleep and privacy and dignity. There were the two things so we had the universal measures turn off lights turn off small equipment close doors, everywhere so that was across all things. We then had specific areas we wanted to do, they had ideas, they were like we could do this in our areas, we could decommission this bit of kit because we never use it and whatever. So there were two set of evaluation criteria, for the doors the lights and the small equipment we had to create a generic, I hate the word generic, we had to create a average calculation, so we looked at the closing of the doors, the turning off the lights and apportioned a value to that. So we put all the energy data in and we looked at the voltage of lighting, we looked at the impact of the closing the doors and then we apportioned a value to that so that was a calculated saving which correlated with the consumption declining. Although our sub metering wasn't that good that it was per room i think that you know they matched in terms of the correlation and the calculations.

Transcription:
And then the other thing that you really need to remember is that as we look to take this to the wider NHS, ensuring its integrity and how its delivered, because you know i've had a lot of people saying just give me the art work give me the posters. You can have the posters, you know what i mean you can have the art work, you can have all the stuff. What you need to learn is the people and speaking to people and engaging with people and the relentless going back and speaking to people works.
And we've seen that again through waste behaviour change program, they are relentless, they go back and back and feedback they've got the data and are not going away they're going to be here for five years, you might as well get used to it and i think that providing that continual engagement, really embedding it in the truer sense, really embedding it, making it part of the, we are absolutely not doing this without behaviour change is really really important.
'And throughout that process, internally within TLC, what are the, how do people report back to you for you to understand the projects like as it's in motion?' I have a weekly catch up call with Lee, I have probably a quarterly presentation that the guys present the data back to me. I get reporting, I get hard metric data. at the end of all the project we will have the full data set and they are collecting some qualitative data at the moment. I'm a great believer in, you give somebody the end goal and I'm frivolous but they are the experts. I don't know how to do that the best way, they might come across things and I don't want to set the path to say you must do this why haven't I got my report every other week and why, and you know because actually they're value is in establishing what actually works, and it's exciting when, i love it that I'm out and about and i see the guys and what they're doing is so good and its good to have feedback from staff and good, you know people, you can see people becoming more engaged and i think that for me is enough of a mark of success.
I think formal reporting is an essential necessary thing and in fact the only report that i'm really interested in is from phase two which we will put out in September, the next piece of research and the work that you'll do to feed into that, and i just think that the more that we can test and evaluate and question things the better. You've just got to keep questioning, it might work here, why did it work here, why did it work here better than at Whipps cross, why didn't it work at Newham so well, why did it work at Mile End so well, why did it work at Frimly so well, there but not here. Why did that person pick that up here, is that because they're structures are different? Is it because, not in an over evaluating way but if you understand what enables success clearly you will be able to replicate success.
They're the things that I think have been missing from behaviour change and I think that the more that we put out the more we'll find, so I'm really excited to see the journey.

Transcription:
One of the things, if we go back to the original reason that we did it I felt really bad for not being able to dedicate time to the people who give people, who were really enthusiastic about doing sustainability and so creating a platform, and i think social media has opened that up anyway in the past four years but to create a platform where staff felt they were valued and their ideas were being shared and learn from and they could showcase what they were doing, they could feel proud of what they were doing, they were recognised for what they were doing and it wasn't in a competitive way. Competition is interesting, when we went back to the original bid so many people came to me and said 'what you need is a competition because healthcare people are really competitive and I really bucked up against that because I think that the people who work in health care can be competitive, i think naturally people want to do better, they want to, but i don't think that it's part of their core fibre over and above their desire to help.
In fact when we looked at it, there were two companies really Global Action Plan and another, who were really looking at taking this forward, and the other company based their entire program on competition and it was all on line and i just didn't see how that could work and in fact i was right. it wasn't about being right but i just had that kind of feeling, when you spoke to people that being valued was more important than competition, and I think that what this other company has done in a university space didn't work well. 'What were the upfront costs of the project?' So the costs were 95 or 96 thousand pounds Skanska and GE paid half of that so each paid 25 GE paid 20. 'And where did the funding go to, was it the contract with GAP?' Yes
'How does carbon culture fit into that? So carbon culture is part of the next phase which is part of the Department of Health Money' Carbon Culture are part of the next phase, part of the Department of Health funding and then the money that we got from the department of health that sort of funding funds carbon culture so that's part of gap's contract, and they are a subcontractor to carbon culture to deliver an online platform, and that's really vital to the EPC as well.
'That would be to do with creating feedback about the project' Yeah and collecting qualitative data, it's a really good place to collect qualitative data.
I've written my first bloggs for it, when Lee said to me that you should write some blogs for it I think it was the firs time when I thought I can actually do through this platform what I wanted to do in the first place which was getting contact with the people who really were enthusiastic about this and share stuff with them, and them engaged and that, so it was quite an important step and i think it will be good, there are so many things we can use the platform for. I think that we need to be careful that we don't use it too much and that it's overloaded and not used what it's supposed to be for. I think there's so much we could use the platform for that would be really productive and helpful, I mean supporting the changing lives campaign.
'I'm going to take it back to the top, because i has some questions about the method of feedback throughout TLC, so there was phase one which was quite structured and a research based set of evaluations?' Although we did have qualitative feedback as well.

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Transcription:
And then phase two moving forwards' Is less bounded.
'You were saying it's more difficult to quantify things but whats the reporting?' I don't think it's more difficult to quantify things i think it's just different. if you think about it, we had ward A versus ward B, they're doing it they're not, they're both the same type of ward they're both metered, they're both you know they don't work with each other, people in ward A don't work with people in ward B that was easy to evaluate and as a piece of research that is really important because you need comparable data. But as we move forward everybody's kind of heard of TLC right? So this is a good thing, we've had some good exec buy in we've won awards for the NHS and in the wider commercial space, all of those things are really good. What it means is that you loose that, nobodies doing it, so people are more aware.
So the evaluation criteria will be the same in terms of patient experience, so did the patient experience improve? And we did the baselining and du du du du but there will be other things, we'll give far more qualitative data and looking at how staff feel, I think that really came through, I think that really came through for what we had last time. We had some stuff felt calmer, the area felt calmer people felt calmer. You can't, I mean you could evaluate that,
'I could if i had my pod' We must put a business case together for the charity of that.
I just think that was a really important point and in fact this time they've picked up a lot on just touching on how its' improving staff health and wellbeing. I'm not saying that we're going to be making any claims about it but it's important that if you see things that people are feeding back, that it wasn't just one person writing back, quite a few people voluntarily fed-back without being probed or asked you have to pick up on, that because it might be a really interesting by product, and then you get into the argument of: is it because people are more engaged the make less mistakes, they're calmer, they're more controlled, they feel part of and valued and part of a team, is it that? I don't know, is it the actual action themselves? Or is that the actions themselves have led to them feeling more part of a team which is better and that's good and equally thumbs up?
It's an interesting thing about, I did some reading about clinical research, I'm fascinated by clinical research and there's so much compelling evidence about engaged staff and deaths in hospitals and i emailed Chris (from GAP) and I said Chris do you think that we should start to measure mortality rates? Because I'd be really interested to see, and then how can we apportion that to TLC or not I don't know. Is it having a positive impact on mortality rates and that is a hospital measure so, you know that's a core hospital measure. if we could prove that one way or the other, I mean if it's not it might not be, but i'm really interested in the link between us engaging, people feeling engaged, and being engaged, how that impacts on their job and how that impacts on the patient. I just think that the more hard metrics as well as the qualitative data and the metrics and data it's just so important. And if you can go and say as a project that it has helped us to reduce our mortality rate, how could you not want to engage with that, how could you not want to do that?

Transcription:
And then in the individual areas, then it was much easier because it might have been something that was metered like a bit of kit. If we were taking a bit of kit out like we did in nuclear medicine that bit of kit has value, it has usage, it has an O&M manual we can look at all of the KWhour data and we can take that out and then the cost was apportioned KWh to the pence that we paid for. so that's how we came up with the cost. 'And i suppose that sums ups what the commercial gains were for the project, the cost savings?' Actually interestingly i don't think that we evaluated the full commercial gains of the project because for example a third fewer patients suffered sleep disruptions so i'd be really interested as we move forward to measure length of stay and weather that's decreasing in the areas that uptake TLC, or areas that don't.
The same with the privacy and dignity you can't measure the cost benefit of somebodies privacy or how that might impact the future things in the NHS. I mean some of these things are really intangible aren't they but there is intrinsically a value in doing those things that we didn't measure.
I think that you can measure it in terms of patient feedback which you guys did.' We did a lot of qualitative, I guess I'm a lover of a lot of quantitive data so I'd love to say this is the pound that area associated with reducing sleep disruptions. it's not about the pounds but it's the pounds that save the money, it's the pounds that get people interested in the project.
'You mean reporting?' It's not a slight that NHS is under huge financial pressure so I mean it's good if you can do all three , improve patients experience, saving money, saving carbon, we're doing this stuff and it's improving the patient experience it's making a real difference. As we move forwards i'd like to capture some of that less tangible or actually established data. 'All the measures were taken from the QMUL study, so that was how you reported on the issues of less sleep deprived?' yes yes yes
'That also sums up a lot of what I was going to ask about baselining. I guess a little bit off topic but the carbon culture platform that was introduced, how do you view its function in the project?' So during the trial, so theres a link isn't there from the trial, and then we got the money from the department of health to run phase two. In both sets of work there was a lot of face to face time. So there was a recognition that we needed to reduce that and the reason that we needed to reduce that is that resources cost money. The savings will be delivered but if the resource carries on being required then at some point that might become not viable financially. There is also such strong evidence about playing data back to people, you know if people can see and understand data they can understand why they can make a difference and so, presenting it in a way that is easily acceptable to everybody, that very clearly shows what ever your focus is, cost carbon energy, a trend whatever it is, was really important, and to create almost like a self regulating community space where people felt part of something bigger.

Transcription:
‘What are the safety considerations of TLC?’ In implementing and going into the wards what are the risks? You’ve got the normal hospital stuff, they’re all CRB checked and you know, they have hospital passes, and that’s the same for any contractor on site ‘That’s interesting that standardised processes do feed into TLC.’ When the guys are on site they are my representatives, they are like little mini me’s. Thankfully not, the place would be in chaos. They abide by our codes of conduct. I meet with them, I know how they’re acting i know how they operate. I think that’s important, i think that i’ve seen how they interact with people. This is a really interesting point, the moral values of an organisation are incredibly important to me, we are really well aligned with GAP’s values and Skanska’s values. GE are quite a good company, they do want to do the right thing. There are some organisations that I am going to be less comfortable but i guess with them going into wards and speaking to people but i guess that some of that grows with integration over time as well. But they act in a certain way they know how to approach people, we went through a kind of hierarchy of this with people and introduced them to people so it’s important that people knew who they were. ‘So the management support for GAPs initiative was the introduction to the NHS staff from you?’ Sure and like the structure, so here’s the chief nurses and here’s the infection control leads here’s, you know when Geraldine and Shona came in, There’s the cultural change program, we could do something with this. Here’s the comms team you need to speak to them about branding. ‘That is the kind of stuff that I am interested in.’
This stuff of course we went through a massive thing. In fact, Chris shouldn’t have any, but if you go back and have a look, I’ll show you the first set of marketing materials that we did and it was about people planet profit and i can’t remember what we were going to call it and in fact operation TLC, I chose the name. So they gave me a list of things to chose, so I said you know we’d had a light session and workshop and then they came up with about six in fact i might still have all of those as well and I really liked it but people didn’t like it, and i was like, that is what we’re using. In fact it’s the only thing I think on this project that I said that is what we’re using, i don’t want to hear it. Which is really interesting. I’m not usually, i’ll listen to what everybody says but I really felt quite strongly about that. I think it says everything.
‘So moving forwards, so taking all of this, just to interrupt this for a moment but my sort of thinking is that you do standardise what you can standardise and that’s really crucial to minimise any leakage of risk going into the parts that actually take a lot of experience and need GAP, so that’s how I’m looking at the project. How do you be like: 1 through 5 needs to be done now 5 through 10 needs to be done now?’ That’s just a project plan, that needs to be done at the beginning of every project.
‘But then to take that to deliver it to the new sites.’ When you start any project you do have that list, mentally you have that list, you have to speak to. The reusable sharps bins that we’re putting out at the moment, right we’re doing a trial like procurement, why would you engage people in procurement? Down the line they’re going to be responsible for all the stuff that we’re going to put in. Any engagement is really important, i’ll just go and speak to people but that’s really important i think that where projects fail often it’s through lack of early engagement.

Transcription:
‘That’s a really interesting point.’ Because then people feel as though it’s forced upon them rather than they’re part of it. Do you mean the people that were helping to enable the project? anyone anyone, ‘But not necessarily the staff and nurses?’ No no no but they’re the end user in this case, them and the patients.
There are different stages but, right if you take the air quality stuff, the air quality project, you’ve got the (Greater London Authority) GLA as in Boris’s office and the four London boroughs everybody’s going to have their ideas. Barts health led the initiative but everyone is going to have their own ideas, loads of different stakeholders, what do you do with that? So the first thing you do is just identify everyone who needs to be involved. one of the first things that we did was get Keski involved to do the branding because with a brand you can build on it, we did a two page overview sent it out to the public health director, medical health director, a couple of the non exec directors who would be interested is always good.
‘Which brings back to your ability to understand different individuals in a network.’ We’ve got to right? I mean i speak to people and they just get annoyed because their project isn’t being taken seriously. So the first question is who isn’t taking it seriously and what have you done to show that your project helps them deliver their deliverables? And the amount of people who just look blankly at me like what are you talking about. If the finance director is giving you a hard time it’s because you have not mentioned finance at all, so tighten it up and present it to him a way that he’s going to understand ‘once you’ve got that initial list of who you need to contact?’
Yeah if you’ve got people who are interested in social impact make sure there’s some social impact stuff in there, make sure that when you’re talking about it you’re talking to them just. It just baffles me and I think that’s half the problem is that people don’t value enough people want to be involved but you’ve got to talk their language and that just sounds really gross but you’ve got to talk in a way that it enlightens people.
I will not go to the research team with a bunch of quotes, and they said that and they said that, i mean what the heck, they’ll be sitting there going, I want numbers I want data I want you to collect surveys and i want to evaluate those surveys. You get no where, and then people get very frustrated. So that’s really, engagement is really important. So my role, I always feel like a fraud really because all i do is put people together and that’s what i do. You know this, you want to know this you want to know that, let’s get together you can deliver something great. That’s just what i can do, i can link people and i think like that normally in a day to day world. That’s how people deliver good stuff, that’s how people get on what ever that good stuff is. I think that’s really important and i don’t think people value that very much.

Transcription:
‘It would be interesting to see how you can work that formally into the delivery of TLC as well’ ‘To really nail it and drive it home so that who ever you give it to it’s fool proof, so this is what you need to do’ I think one of the problems with trying to do that is you don’t take into consideration personalities, political landscapes, people’s agendas. And you don’t take into consideration what people’s ability to do. The person leading TLC somewhere else might be a data person, they might be a really bad communicator, they might be really good, they might have a great relationship with somebody but not somebody else, they might be political. This is where the scoping work for TLC is really important because I think people will have, every project will be different. I think the outcomes will actually be quite different too and different people will drive different things different people will pick up different things and we will hopefully at the end of it, well not that it will end but we will start building, building, building this database of research and evidence that we can use and that’s openly accessible for everyone to use.
The real thing is that I just don’t think you can standardise that and I think people try and standardise that too much all the time. Give me a project plan, i’ll give you a project plan for a project, somebody else will give you a different project plan for the same project if you asked four project managers it would be really interesting to see what they did, and not what they wrote down on paper either. Because if you said to me or trevor said to me, i want you to deliver this project the first thing that I do is speak to people i just think what they’d be interested in and some people might not right we’re starting on day one and we’re going to this on day one and this on three and they might completely miss the engagement bit. I’m probably a bit the other way I don’t write down dates i don’t keep people to dates. But the project will deliver, I’m good at keeping things on track.
‘You’re goal orientated i think’ I think that trying to standardise people’s personalities doesn’t work and i think a lot of the leadership literature that’s exactly what academics try and do. name all all the qualities that you’ve ever seen in a great leader, there’s a gazilion of them and then they try and piece it all together, if you have this set of qualities you will be a great leader. No they won’t and if you look at all the varieties of the different leaders and all the qualities, personality is a big thing and the delivery of that and how they act and the values are far more important and what they value, and also the context in which they’re working in, would winston churchill do a great job today? He wouldn’t. ‘That’s a really good point’ Thank you those are all the questions I have.

Appendix B

Interview	31.07.14	Lee Comerford	Project Manager of TLC	Works at GAP

Guide Document: Questions	Category			
How did TLC come about and what's GAP's relationship with the NHS?				
How did GAP become involved?				
What is GAP's role in TLC?				
What are the core aims of TLC?				
What are the efficiencies created in TLC?				
How was the impact of TLC monitored? in term of cost and benefits - (staff patients environment)?				
Feedback gathered and analysed, then given to the management?				
What action created the biggest cost saving?				
What action created the biggest rise in patient satisfaction?				
What action created the biggest rise in staff well being?				
What were some of the unexpected gains in the project?				
How is TLC planned out and structured?				
How is TLC implemented?				
Were there any differences in Barts and Frimly?				
In individual hospitals				
What is the governance and reporting structure of TLC?				
What are the reporting structures in GAP?				
What technologies and formal sign offs do you use in your reporting?				
How were risks assessed in TLC?				
How did you create partnerships within the NHS that can aid the NHS in achieving efficiency?				
What processes were used in for example identifying the initiatives?				
How can you encourage new initiatives to be identified by other stakeholders?				
How was the project evaluated and defined and costed in order to report upwards to governing bodies?				
What is the duration of TLC?				
Who are your partners in TLC?				
What is the role of Carbon Culture?				

Transcription:
How did TLC come about and what's GAP's relationship with the NHS to the project?' Operation TLC Stands for turn off equipment lights out and close doors, those are the three simple actions that we ask staff to do, health care staff. It came about after quite an extensive scoping exercise into what are the behaviours and behaviours, actions, that firstly staff have the control of, that influence the amount of energy that is used in a hospital environment, and secondly what are the easy to do actions. How did we work that out? that was through focus groups - what they do day to day what might use energy 'Probe: could you describe these processes more, how many groups and how long did it take?....' I wasn't there for the pilot phase but I know what was done from picking the project up from phase two From the pilot i believe that 3-4 focus groups estates facilities staff, broad mix staff managers, 'Prompt to ask were there porters and cleaners as well?' Yes there was a good mix GAP person leading introduces the workshop, ask questions and discussions with staff and recorded and analysed. 'I wander if there was a difference between the groups, there must have been a massive difference..' Between what they thought? 'Yeah..' Estates manager may be frustrated with how people use the buildings People on the floor maybe don't know how they can impact things surveys. It was good to have everyone together.
The idea of TLC was to create a brand that people could relate to and say oh TLC is about these specific things. It's been really successful because all we have to do is walk into Barts with a t-shirt on and people come up to us and are like, I turn this off I do these actions. As a brand it's been really really successful.
What's the relationship between GAP and the NHS?' Pilot was the first project between GAP and the NHS.
It's obviously an area of interest to GAP because the NHS energy bill is £630 million per annum and that translates to a lot of carbon. So there's a big opportunity, there is also a lot of interest from the funding from the Department of Health to reduce their energy bill as energy prices are going up so
There's a risk there and this is money that could be spent of patient care. Funding from the department of health was a pot of money that was made available specifically too.

Transcription:	
The pilot was a blind study. 'So was your brief something like reduce energy through behaviour change, come with an idea, pitch it and then win the work?' Yes the goal of the pilot was to reduce energy but we didn't know how much would be possible, and to work out what actually works and how much money you could save.	Outcomes
The pilot was primarily the RLH and also St Barts, but this was during the merging of the Whipps Cross Newham and Mile End, it's grown.	
Officially, what's GAP's title?' We like to think of ourselves as a partner with Barts for their behavioural sustainable change projects, so we're like a partner rather than a contractor because we help with lots of other things as well.	
Probe:You have lots of strong relationships with internal departments and staff, like communications, patients and staff. What are some of the departments and groups that you have strong relationships with?' The majority of the behaviour change that we try to achieve is with staff in hospitals, on the ground, on wards, 24 hour wards, day care wards, outpatient areas and departments of medical health care. The main relationships are with those people on the ground.	
In every area we have a list of champions, we don't call them that but their stakeholders who we would go and have repeated conversations more and talk to again.	
Like who are just more interested or in charge more?' Normally their in a position of responsibility but not always, there could be a keen green.	
How do you structure your time and plan for that project?' It's very time consuming, Barts has around 15,000 members of staff, so if we want to talk to every member of staff that's going to take a lot of man hours. The other thing we know is that in all of our campaigns what ever we're asking staff to do we need to ask them more than once if their going to change their behaviour. To give an example - quiet time, which was an initiative where we ask staff in 24 hour wards to switch off lights for a few hours, so that the patients can rest but also to get an energy saving. We visited most areas three times for that to eventually be done. Two to three times that were needed for it to be implemented. There were a few, always a few but very few areas would just put it up straight away.	
Quiet time: We select our initiatives based on the opportunity, with quiet time we can save this much co2, we can save this much energy it has these patient benefits, so are we going to do it or are we going to do night time switch offs? We make a decision based on the opportunity and how much resources are needed and then we go ahead and plan the visits and any other comms that we may support those with.	

Transcription:
Were there any differences in hospitals?' 'Like were there any differences in if they were like yeah love it, doing it straight away?' I haven't myself done engagement in Frimly but people who have done engagement in Frimly say that they are much easier to talk to and, friendlier but i guess what they mean by that is that they just have more time, they are not as under pressure or busy or low in resources so that they can have a conversation. What we tend to find in the RLH is that staff are just really busy they want to talk to you and they want to help but they're just really busy and under pressure too. That does vary per hospital.
Another example is at Mile End because it's a different kind of .. ('Patient?') Patient, there it's psychiatric or elderly it's not emergency so staff have a little more time to talk to you which makes it easier. The other things is that some wards are better managed or better resourced and those wards that are better managed and it's easier to talk to those wards than others, so those wards that are under a lot of pressure, that are under resourced or is not managed properly.
'How much of that do you know before hand? Do you just go in and like..' Well we use a google doc and every engagement we do we create three or four different columns and there's space for the time, where you're going, who you spoke to and a comment of what was discussed and an observation, so we walk around with an I pad or a phone and before you go into a ward the idea is that you read a the history of what has happened. 'Brilliant.'
So you would see that last time you went you would see that a ward is always busy.
Before you go in you would see - tried to talk to them but they wouldn't because they were too busy or waited for 10 minutes and went away because no one tended to me. The other thing that we do is we grade wards one two or three, so one relates to wards that are carrying out TLC actions and also that when we ask them to do something will actually do it 'That's best?' Yeah that's the best.

Transcription:
Three means that we've tried several occasions and they're not doing anything Two is somewhere in the middle. So depending on the campaign we might focus on ones twos or threes. And recently we decided to not put any more effort into threes for example towards the end of the project, just because we feel it would be more effective to focus on the ones and twos' 'Once you've gone in and done your first go, you've got your ones two three then do you do them all again?' Generally everybody, or all areas have had all engagements, it's just in the last quarter we've decided to use our resources more effectively, drive ones and twos. The ones and twos might get slightly different engagement for example with the twos we want to understand what are the barriers and collect more information on what is stopping them. For example we have door stickers that remind people to close doors. If the area if there are no door stickers we'll go into a two are and ask them why you're not doing it. They might tell us that the problem is, that it's hot weather and don't have air conditioning in my drug stores, and i'm worried that it will deteriorate the quality of the drugs.
And then obviously you link into the bigger processes of help desk?' Yeah we do report things like this but also it links into our learning about the barriers. But obviously we couldn't do that with a three because we don't get that far in the conversation.
We also carryout behaviour audits at the start of the project. Before phase two we did a full baseline of behaviour audits in wards an other lights turned off lights and equipment. We do audits every three months about how long does that go on for.
How long does that go on for, when does it stop?' Hopefully never, we're creating an auditing tool with Carbon Culture so that the auditor can use a tool to make it quicker. Manually it takes 30 minutes per ward and would be 10 minutes.
So some of the benefits are..' So 5 of the key benefits are Patient experience.
And what are the main actions?' Closing single patient doors, quiet time because patient gets to sleep in the day. And you'd be surprised how many don't want visitors lights out during quiet time and less bright and easier to sleep and rest.
Secondly it would be staff benefits - 'What would the main benefits be?' Quiet time again, benefit for staff is that they have time to do their notes. They have more satisfied patients, less complaints. We've had complaints about staff coming in at two in the morning to deal with patients but then we've told staff that they should use the local light for the bay and not turn the whole things on. It seems really obvious but it saves energy and also stops complains. Thirdly it's also an opportunity to work with our champions for them to be rewarded and to work with their staff and improve. A lot of our programs, well most of our initiatives reward staff and 'give them positive feedback'

Transcription:
The third thing that we measure is behavioural measures. The behavioural measures include the amount of people that have been reached and the total number of actions that have been done. The next area is energy savings, this is Kw money co2.
What's the biggest spender in terms of energy consumption?' We're pulling together the results from phase two so we'll know from the pilot. A lot of the savings from equipment not needed, found by champions who found a bit of equipment that wasn't needed. Night time switch off as well, a lot of the equipment was being left on.
Do you want to talk more about technology? 'I was going to ask you about the reporting you talked about the google docs and the upcoming platform for data logging, doing manual checks so what was the governance and reporting structures in phase two?' Phase two has been funded by the Department of Health, they're elective measurement verification (M and V) partner is oxford.
Can i just ask was that funding up for grabs or did you pitch for it?' It was a funding pot that was created specifically to help trusts reduce their energy but it was a big pot and there's lots of different projects going on all around the country.
I don't know if GAP and NHS had a relationship before that but there were lots of other trusts who dropped out, there was also a technology partner called ZAP not carbon culture before carbon culture.
There is also a rather disgusting, rather horrible excel template which we have needed to fill in every two or three months which has got an energy diary and space to write our progress. That goes to Cambridge and they then send that on to DofH
The final reporting for that has already been submitted. We've also asked if we can provide a report that details the benefits of the whole program outside of that, it's that excel is quite limited in the way that we can show. We are providing a 20 page report.
prompt: Just to recap of the technologies and reporting mentioned so far' At the moment we have a weekly catch up with Fiona but are not sharing results because we don't have a live dashboard of where we're up to. We have the weekly reports and then we have every three months a more detailed review with Fiona and there'll be a powerpoint presentation with tables of what we achieve over there but that hasn't been completely standardised. It'll include the number of staff engaged, the number of ones two and threes.
Also reporting to us are carbon culture who give us how many stories and people have signed up to the platform, carbon culture are in partnership. Carbon culture give a weekly call, send figures at the end of the call, there's a delivery timeline and action plan. There's two timelines, Carbon Culture timeline for delivery of technology aspects and the project as a whole which hasn't been share with Fiona. GAP's project management toolkit is a gantt chart that you fill in as a tool kit, an action plan, risk measurement template.
How do you split that?' Generally with GAP's projects they are split into scope, design, delivery and evaluation. Tools and kits split into those phases.

Transcription:
TLC is slightly different, it has lots of little plan, do, check cycles. Although we've had baselines and some initial scoping as well as big delivery phases and evaluations there's loads of little scoping, design, deliver evaluate for each campaigns within the delivery phase. That's the way GAP operate, it means that we only do what's worth while doing and we make sure we measure the success of what we do and it feeds into the next thing that we do. We capture the information as we go along. Now its a case of bringing it all together we have a lot of the figures as we've gone along. 'Are Frimly and Barts are part of the same funding the Department of Health?' Yes, Frimly are a smaller budget it's a smaller trust and are slightly more delayed as their work is due to go on till the end of the year.
Leading:'Is phase three development, doing things quicker, streamlining and packaging?' Well phase three will be the Skanska EPC which is at Newham, Whipps and Mile End only at those three hospitals and not at the RLH so it will be a continuation and Barts have had an extra year and a half of engagement, where as Whipps and Newham aren't as far along so it will be to carry on and if not get them further.
'Even though the project gets easier over time naturally to implement as it develops, are there any hospitals that were easier or do you think Barts as a trust and Frimly are kind of similar as a whole?' From what I know, if we look at the things that are needed for TLC to be successful one of those is senior stakeholder buy in. So the reason that we've been able to achieve so much at Barts is that Trevor and Fiona have really bought into the campaign and they are senior champions of the program, and will make things happen.
prompt 'In every hospital in the trust as well.' Right but you're talking about specific hospitals? 'Well it strikes me, and from speaking to Paula as well (a researcher looking into energy reduction in hospital theatres they're so different, they seem different on the surface but does that matter when you're doing something like this?' Well there are a lot of similarities with what staff do, they are under, so i think the main differences are, i wouldn't say between hospitals so much but in the different types of areas not between hospitals. For example we've done very little engagement in An and E they don't have time to talk to us it's not practical to go in there. It doesn't matter what hospital it is.
All theatres have really common components, so something we've had lots of success in the theatres and they have common elements and equipment.

Transcription:
Leading question: 'would you say that it's a really procedures because of the intensity of the environment and it's so high risk?' Yeah yeah. So the challenges have been more based on areas than hospitals. Having said that there are on the embedding side of things, there have been difficulties where Barts has been going through this large merger, there are lots of other changes going on at the same time and there are lots of other behaviour change campaigns going on at the same time. Then it is difficult to work out where operation TLC fits into that. To give an example, the 'because we care' campaign following the CQC audit, there is less focus on that now and the over arching campaign is changing lives and if we fit TLC into that and embedded it in the trust and that changes, it is going to be difficult to embed that. Whereas at Frimly it seems like there's more stability, and you are actually able to get the senior nurses together and pick one or two actions that they want to focus on, which was to turn lights off at night. They were able to get senior nurses to agree that they wanted to improve patient feedback for privacy at night.
Whereas at Barts it's been really difficult to get people to agree on one or two things and agree because they want to do everything. So for delivery of TLC in a complex trust like Barts it becomes difficult when you're trying to embed it.
What's the role of the carbon culture platform, what's the potential for it how do you want to use it?' The pilot was delivered using GAP's main technique of face to face engagement, we realised two things: that to be everywhere with the same amount of engagement takes a lot of resources and also that every message that gets, I mentioned that staff need to hear things more than once to change their behaviour, that's common knowledge, it doesn't need to be face to face engagement every time, we use comms and bulletins to deliver that but not all staff see that or have access to it so we wanted a way to reach staff. In addition we want auditing to be more efficient more accurate and thirdly we want to have a standardised reporting structure.
One will be a communications platform for staff - there will be screens, PCs and mobile phones, second is an auditing tool, and a management dashboard.
How did you asses potential risks?' We were lucky in that we had the results we knew that the pilot was successful but didn't know if it would be successful in new hospitals.
We have a risk register to identify behaviours that don't save energy. We had an induction to the sight with facilities manager. Second might be for example that staff are even busier than they were at other hospitals. So other ways to engage them are through technologies or meetings that they already have. 'So you would say that technology can mitigate risk?' Yeah absolutely.

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Appendix C Ethics approval

UCL RESEARCH ETHICS COMMITTEE
ACADEMIC SERVICES

22 June 2015

Dr Lucy Campbell
UCL BEAMS

Dear Dr Campbell

Notification of Ethical Approval
Project ID: 7127/001: Vending and retail, making healthy choice the norm

I am pleased to confirm in my capacity as Chair of the UCL Research Ethics Committee that I have approved your study for the duration of the project, until June 2016.

Approval is subject to the following conditions:

1. You must seek Chair's approval for proposed amendments to the research for which this approval has been given. Ethical approval is specific to this project and must not be treated as applicable to research of a similar nature. Each research project is reviewed separately and if there are significant changes to the research protocol you should seek confirmation of continued ethical approval by completing the 'Amendment Approval Request Form':

2. It is your responsibility to report to the Committee any unanticipated problems or adverse events involving risks to participants or others. Both non-serious and serious adverse events must be reported.

   Reporting Non-Serious Adverse Events
   For non-serious adverse events you will need to inform Helen Dougal, Ethics Committee Administrator (ethics@ucl.ac.uk), within ten days of an adverse incident occurring and provide a full written report that should include any amendments to the participant information sheet and study protocol. The Chair or Vice-Chair of the Ethics Committee will confirm that the incident is non-serious and report to the Committee at the next meeting. The final view of the Committee will be communicated to you.

   Reporting Serious Adverse Events
   The Ethics Committee should be notified of all serious adverse events via the Ethics Committee Administrator immediately the incident occurs. Where the adverse incident is unexpected and serious, the Chair or Vice-Chair will decide whether the study should be terminated pending the opinion of an independent expert. The adverse event will be considered at the next Committee meeting and a decision will be made on the need to change the information leaflet and/or study protocol.

On completion of the research you must submit a brief report (a maximum of two sides of A4) of your findings/concluding comments to the Committee, which includes in particular issues relating to the ethical implications of the research.

Appendix D Staff Survey Questions

1. What role best describes your function within your organisation?
2. What is the main Barts Health Trust site you work at?
3. Do you work mainly in the day, mainly over night or a fairly even mix between days and nights?
4. What is your usual working environment?
5. How much do you spend on food and drink during an average working day?
6. How often do you use the following?
Hospital canteen On-site cafes On-site vending machines Off-site shops (to buy food or drink to consume at work)
7. In an average day, what would you usually eat while at work?
Hot food, bought on site
Hot food, bought from shop elsewhere
Hot food, brought from home
Cold food, bought on site
Cold food, bought from shop elsewhere
Cold food, brought from home
On a scale from 1 (poor) to 5 (excellent), please tell us how you feel about the following aspects of the food and drink currently available for staff from Barts Health Trust
CANTEENS,
CAFÉ BARS,
VENDING MACHINES
Price (FOOD)
Price (DRINK)
Availability of healthy options (FOOD)
Availability of healthy options (DRINK)
Overall quality (FOOD)
Overall quality (DRINK)
Amount of information available on nutritional content, including information provided about calories (FOOD)
Amount of information available on nutritional content, including information provided about calories (DRINK)
11. How important is it for you that Barts Health Trust food and drink provision is based on principles of sustainability (such as avoiding harm to the local environment and providing support to local businesses)?
12. What would you most like to change about food and drink at Barts Health Trust?
13. On a scale from 1 (poor) to 5 (excellent), please tell us how you feel about the following aspects of the food currently available from Barts Health Trust for PATIENTS:
Overall quality
Flexibility of menus to meet the varied nutritional needs of different patients (e.g. those who are malnourished
Amount of information available to staff on nutritional content of patient food
14. Where do you buy the food and drink from that you consume during a usual night shift? (tick as many boxes as apply to you)
Buy it from hospital canteen before it closes
Buy it from on-site vending machine
Order a delivery Buy it from shop/outlet on way in to work
Go out and buy it from shop/outlet during night shift
Bring it from home
15. Please tell us about WHAT you currently eat and drink during a usual night shift and any differences between this and what you would ideally like to eat and drink during these shifts (tick as many boxes as apply to you)

Hot meal
Cold meal
Snacks No food
Hot drink
Fizzy drink / squash
Fruit juice
Mineral water
Tap water
No drinks
Current situation Ideal situation
17. At what times do you currently take breaks for eating/drinking during a usual night shift?
9pm 10pm 11pm Midnight 1am 2am 3am 4am 5am 6am 7am I don't get this break
First break
Second break
Third break
18. OPTIONAL QUESTION FOR ALL STAFF: if you would like to enter the prize draw to win a hamper, please enter your email address here. If you prefer to remain anonymous, simply skip this question.

Appendix E Staff Survey Dimensions

	0	1	**2**	3	4	5	6	7	8	9	10
spendlot if	< £1	£1-1.99	£2-2.99	£3-3.99	£4-4.99	£5-5.99	£6-6.99	£7-7.99	£8-8.99	£9-9.99	> £10

useOtherRetAlot if	Hospital canteen	Never	Few times year	Few times month	Few times week	Every day
	On-site cafes	Never	Few times year	Few times month	Few times week	Every day
useVendAlot if	On-site vending machines	Never	Few times year	Few times month	Few times week	Every day
useExtRetAlot if	Off-site shops (buy food or drink &consume at work)	Never	Few times year	Few times month	Few times week	Every day

otherRetailFoodBad if	Availability of healthy options (FOOD)	1	2	3	4	5
	Overall quality (FOOD)	1	2	3	4	5
	Amount of information available on nutritional content, including information provided about calories (FOOD)	1	2	3	4	5
	Availability of healthy options (FOOD)	1	2	3	4	5
	Overall quality (FOOD)	1	2	3	4	5
	Amount of information available on nutritional content, including information provided about calories (FOOD)	1	2	3	4	5
otherRetailDrinkBad if	Overall quality (DRINK)	1	2	3	4	5
	Availability of healthy options (DRINK)	1	2	3	4	5
	Amount of information available on nutritional content, including information provided about calories (DRINK)	1	2	3	4	5
	Availability of healthy options (DRINK)	1	2	3	4	5
	Overall quality (DRINK)	1	2	3	4	5
	Amount of information available on nutritional content, including information provided about calories (DRINK)	1	2	3	4	5
vendFoodBad if	Availability of healthy options (FOOD)	1	2	3	4	5
	Availability of healthy options (DRINK)	1	2	3	4	5
	Overall quality (FOOD)	1	2	3	4	5
vendDrinkBad if	Overall quality (DRINK)	1	2	3	4	5
	Amount of information available on nutritional content, including information provided about calories (FOOD)	1	2	3	4	5
	Amount of information available on nutritional content, including information provided about calories (DRINK)	1	2	3	4	5

eveCurrentBreaksPoor if	Current situation - On my ward / at my exact place of work	1	
	Current situation - In a staff kitchen or break room on my ward	3	
	First break Second break Third break	I don't get this break	any other response

opportunityToUpsellEve if	Buy it from on-site vending machine	3
	Order a delivery	4
	Buy it from shop/outlet on way in to work	5
	Go out and buy it from shop/outlet during night shift	2
	Bring it from home	6
	Buy it from hospital canteen before it closes	1

retailOtherCostHigh if	Price (FOOD)	1	2	3	4	5
	Price (DRINK)	1	2	3	4	5
	Price (FOOD)	1	2	3	4	5
	Price (DRINK)	1	2	3	4	5
vendingCostHigh if	Price (FOOD)	1	2	3	4	5
	Price (DRINK)	1	2	3	4	5

	Current situation - Hot meal	4
	Current situation - Cold meal	3
	Current situation - Hot drink	8
	Current situation - Mineral water	10
	Current situation - Tap water	9
	Current situation - In a hospital canteen area	6
	Current situation - In a hospital cafe area	5
	Current situation - Elsewhere in the hospital	4
	Current situation - Outside the hospital	2
eveCurrentNutritPoor if	Current situation - Snacks	2
	Current situation - No food	1
	Current situation - Fizzy drink / squash	6
	Current situation - Fruit juice	7
	Current situation - No drinks	5
tab eveIdealSituPoor if	Ideal situation - Snacks	2
	Ideal situation - No food	1
	Ideal situation - Fizzy drink / squash	6
	Ideal situation - Fruit juice	7
	Ideal situation - No drinks	5
	Ideal situation - On my ward / at my exact place of work	1
	Ideal situation - In a staff kitchen or break room on my ward	3
	Ideal situation - Hot drink	8
	Ideal situation - Hot meal	4
	Ideal situation - Cold meal	3
	Ideal situation - Mineral water	10
	Ideal situation - Tap water	9
	Ideal situation - In a hospital canteen area	6

	Ideal situation - In a hospital cafe area	5
	Ideal situation - Elsewhere in the hospital	4
	Ideal situation - Outside the hospital	2

Appendix F Inferential results for staff catering survey

spend over £4 per day					
characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.57	1.00	baseline		
night	0.56	0.95	0.78	0.65	1.38
work environment					
Other (please specify)	0.57	0.72	0.39	0.34	1.53
Out in the community	0.53	0.60	0.20	0.28	1.31
Office-based (not on a hospital site)	0.65	1.00	baseline		
Hospital-based	0.56	0.68	0.15	0.41	1.14
main worksite					
Other (please specify)	0.46	1.33	0.58	0.48	3.71
Prescot Street	0.39	1.00	baseline		
Mile End	0.49	1.51	0.33	0.66	3.45
Newham University Hospital	0.51	1.64	0.22	0.74	3.63
St Bartholomew's	0.65	2.93	0.01	1.34	6.40
Whipps Cross	0.53	1.80	0.14	0.83	3.89
Royal London	0.62	2.64	0.01	1.25	5.54
job role					
Other (please specify)	0.51	0.97	0.89	0.62	1.52
Junior Doctor	0.52	0.99	0.98	0.45	2.19
Facilities Support Staff	0.74	2.72	0.06	0.95	7.81
Doctor/Consultant	0.62	1.53	0.19	0.81	2.88
Technical & healthcare support	0.64	1.66	0.11	0.90	3.07
Manager	0.68	1.99	0.00	1.28	3.08
Allied Healthcare Professional	0.52	1.02	0.92	0.72	1.45
Nurse	0.61	1.48	0.03	1.05	2.09
Admin & Clerical	0.52	1.00	baseline		

bad opinion of other retail food					
characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.95		baseline		
night	0.98	2.06	0.25	0.60	7.13
work environment					
Other (please specify)	0.97	1.58	0.59	0.30	8.37
Out in the community	0.96	1.36	0.75	0.20	9.19
Office-based (not on a hospital site)	0.95	1.00	baseline		
Hospital-based	0.96	1.24	0.68	0.44	3.49

main worksite					
Other (please specify)	0.87	1.28	0.76	0.26	6.31
Prescot Street	0.84	1.00	baseline		
Mile End	0.98	7.67	0.02	1.34	44.03
Newham University Hospital	0.96	5.20	0.02	1.29	20.92
St Bartholomew's	0.95	3.74	0.05	1.01	13.77
Whipps Cross	0.97	6.10	0.01	1.59	23.35
Royal London	0.97	5.52	0.01	1.68	18.12
job role					
Other (please specify)	0.93	0.91	0.84	0.36	2.28
Junior Doctor	0.95	1.17	0.88	0.15	9.33
Facilities Support Staff	0.91	0.67	0.63	0.14	3.31
Doctor/Consultant	0.95	1.26	0.77	0.28	5.72
Technical & healthcare support	0.96	1.64	0.52	0.36	7.38
Manager	0.96	1.65	0.30	0.64	4.26
Allied Healthcare Professional	0.99	6.59	0.01	1.48	29.38
Nurse	0.96	1.74	0.21	0.73	4.15
Admin & Clerical	0.94	1.00	baseline		

bad opinion of other retail drink					
characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.93		baseline		
night	0.93	0.97	0.94	0.44	2.12
work environment					
Other (please specify)	0.89	0.59	0.37	0.18	1.87
Out in the community	0.93	1.02	0.98	0.21	4.97
Office-based (not on a hospital site)	0.93	1.00	baseline		
Hospital-based	0.94	1.11	0.81	0.46	2.68
main worksite					
Other (please specify)	0.85	1.38	0.66	0.33	5.79
Prescot Street	0.81	1.00	baseline		
Mile End	0.95	4.82	0.03	1.20	19.29
Newham University Hospital	0.95	4.36	0.02	1.30	14.62
St Bartholomew's	0.93	3.22	0.05	1.03	10.07
Whipps Cross	0.95	4.40	0.01	1.39	13.89
Royal London	0.94	3.77	0.01	1.34	10.60
job role					
Other (please specify)	0.90	0.89	0.76	0.42	1.89
Junior Doctor	0.91	1.05	0.95	0.23	4.79
Facilities Support Staff	0.80	0.39	0.12	0.12	1.29
Doctor/Consultant	0.95	2.08	0.33	0.47	9.18

Technical & healthcare support	0.92	1.23	0.72	0.41	3.71
Manager	0.94	1.55	0.28	0.70	3.42
Allied Healthcare Professional	0.98	5.27	0.00	1.78	15.62
Nurse	0.95	1.81	0.10	0.89	3.68
Admin & Clerical	0.91	1.00	baseline		

bad opinion of vending food					
characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.72		baseline		
night	0.91	4.22	0.0000	2.25	7.94
work environment					
Other (please specify)	0.66	0.65	0.2830	0.29	1.43
Out in the community	0.74	0.97	0.9410	0.43	2.21
Office-based (not on a hospital site)	0.75	1.00	baseline		
Hospital-based	0.75	1.03	0.9280	0.59	1.77
main worksite					
Other (please specify)	0.72	1.48	0.4750	0.51	4.33
Prescot Street	0.64	1.00	baseline		
Mile End	0.58	0.79	0.5810	0.34	1.83
Newham University Hospital	0.80	2.41	0.0430	1.03	5.65
St Bartholomew's	0.73	1.59	0.2640	0.71	3.58
Whipps Cross	0.69	1.27	0.5630	0.57	2.81
Royal London	0.81	2.58	0.0160	1.19	5.56
job role					
Other (please specify)	0.73	0.90	0.6960	0.54	1.51
Junior Doctor	0.64	0.60	0.2640	0.24	1.47
Facilities Support Staff	0.77	1.19	0.7630	0.38	3.77
Doctor/Consultant	0.66	0.64	0.2140	0.32	1.29
Technical & healthcare support	0.75	1.02	0.9460	0.51	2.07
Manager	0.73	0.94	0.7790	0.59	1.49
Allied Healthcare Professional	0.76	1.10	0.6280	0.74	1.65
Nurse	0.77	1.13	0.5400	0.76	1.70
Admin & Clerical	0.74	1.00	baseline		

bad opinion of vending drink					
characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.72		baseline		
night	0.88	3.03	0.00	1.72	5.34

work environment					
Other (please specify)	0.66	0.61	0.23	0.28	1.36
Out in the community	0.72	0.84	0.68	0.37	1.91
Office-based (not on a hospital site)	0.75	1.00	baseline		
Hospital-based	0.74	0.95	0.87	0.55	1.66
main worksite					
Other (please specify)	0.69	1.50	0.46	0.52	4.33
Prescot Street	0.60	1.00	baseline		
Mile End	0.58	0.92	0.86	0.40	2.15
Newham University Hospital	0.80	2.73	0.02	1.17	6.40
St Bartholomew's	0.73	1.87	0.13	0.83	4.21
Whipps Cross	0.68	1.42	0.39	0.64	3.16
Royal London	0.82	3.04	0.01	1.40	6.58
job role					
Other (please specify)	0.73	0.97	0.91	0.58	1.62
Junior Doctor	0.62	0.56	0.20	0.24	1.35
Facilities Support Staff	0.77	1.25	0.70	0.40	3.96
Doctor/Consultant	0.64	0.62	0.17	0.31	1.23
Technical & healthcare support	0.77	1.21	0.61	0.59	2.49
Manager	0.73	0.98	0.94	0.61	1.57
Allied Healthcare Professional	0.76	1.15	0.49	0.77	1.72
Nurse	0.77	1.21	0.34	0.81	1.82
Admin & Clerical	0.73	1.00	baseline		

receive poor nutrition on night shift					
characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.05		baseline		
night	0.53	26.47	0.00	16.34	42.89
work environment					
Other (please specify)	0.14	10.49	0.10	0.63	175.30
Out in the community		1.00			
Office-based (not on a hospital site)	0.03	1.00	baseline		
Hospital-based	0.13	10.20	0.10	0.65	160.23
main worksite	0.09				
Other (please specify)	0.26	0.13	0.25	0.00	4.21
Prescot Street	0.07	1.00	baseline		
Mile End	0.16	0.09	0.14	0.00	2.26
Newham University Hospital	0.13	0.34	0.47	0.02	6.27
St Bartholomew's	0.11	0.22	0.31	0.01	4.01
Whipps Cross	0.13	0.19	0.26	0.01	3.41
Royal London		0.23	0.31	0.01	4.01

job role	0.11				
Other (please specify)	0.17	1.42	0.49	0.53	3.78
Junior Doctor	0.08	3.24	0.07	0.93	11.28
Facilities Support Staff	0.15	0.82	0.87	0.07	9.18
Doctor/Consultant	0.12	2.58	0.10	0.85	7.82
Technical & healthcare support	0.07	1.68	0.39	0.51	5.51
Manager	0.12	0.78	0.68	0.24	2.52
Allied Healthcare Professional	0.16	1.77	0.19	0.75	4.17
Nurse	0.09	2.96	0.00	1.41	6.25
Admin & Clerical		1.00	baseline		

receive poor break on night shift					
characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.08		baseline		
night	0.80	72.06	0.00	40.04	129.70
work environment					
Other (please specify)	0.22	4.56	0.12	0.68	30.75
Out in the community	0.14	1.57	0.71	0.15	16.81
Office-based (not on a hospital site)	0.12	1.00	baseline		
Hospital-based	0.18	2.94	0.18	0.61	14.27
main worksite					
Other (please specify)	0.09	0.14	0.14	0.01	1.94
Prescot Street	.	1.00	baseline		
Mile End	0.13	0.39	0.17	0.10	1.51
Newham University Hospital	0.19	1.10	0.77	0.57	2.15
St Bartholomew's	0.19	1.07	0.83	0.59	1.94
Whipps Cross	0.16	0.71	0.26	0.39	1.29
Royal London	0.19	1.00			
job role					
Other (please specify)	0.18	2.04	0.12	0.82	5.06
Junior Doctor	0.33	7.77	0.00	2.43	24.83
Facilities Support Staff	0.22	3.18	0.14	0.68	14.93
Doctor/Consultant	0.20	2.59	0.09	0.87	7.73
Technical & healthcare support	0.22	3.29	0.02	1.19	9.11
Manager	0.10	0.53	0.29	0.16	1.72
Allied Healthcare Professional	0.17	1.71	0.17	0.80	3.69
Nurse	0.22	3.41	0.00	1.73	6.74
Admin & Clerical	0.13	1.00	baseline		

would ideally receive poor catering on night shift

characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.06		baseline		
night	0.56	28.39	0.00	17.54	45.96
work environment					
Other (please specify)	0.14	3.68	0.25	0.41	33.29
Out in the community	0.08	1.17	0.91	0.06	21.40
Office-based (not on a hospital site)	0.07	1.00	baseline		
Hospital-based	0.14	3.49	0.19	0.54	22.73
main worksite					
Other (please specify)	0.09	0.24	0.41	0.01	7.02
Prescot Street	0.18	1.00	baseline		
Mile End	0.07	0.16	0.24	0.01	3.28
Newham University Hospital	0.16	0.86	0.91	0.06	12.01
St Bartholomew's	0.12	0.49	0.59	0.04	6.62
Whipps Cross	0.13	0.50	0.61	0.04	6.92
Royal London	0.14	0.64	0.74	0.05	8.53
job role					
Other (please specify)	0.10	1.02	0.97	0.40	2.62
Junior Doctor	0.22	3.97	0.02	1.23	12.82
Facilities Support Staff	0.07	0.60	0.67	0.05	6.60
Doctor/Consultant	0.14	1.83	0.27	0.62	5.37
Technical & healthcare support	0.16	2.35	0.11	0.83	6.63
Manager	0.04	0.30	0.09	0.08	1.18
Allied Healthcare Professional	0.13	1.47	0.33	0.67	3.24
Nurse	0.18	2.75	0.00	1.40	5.41
Admin & Clerical	0.10	1.00	baseline		

purchasing food other than in canteen for night shift					
characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.09		baseline		
night	0.84	78.16	0.00	42.71	143.03
work environment					
Other (please specify)	0.22	2.36	0.25	0.54	10.31
Out in the community	0.12	0.56	0.58	0.07	4.31
Office-based (not on a hospital site)	0.15	1.00	baseline		
Hospital-based	0.18	1.62	0.40	0.52	5.02
main worksite					
Other (please specify)	0.18	2.04	0.60	0.15	28.29

Prescot Street	0.14	1.00	baseline		
Mile End	0.15	1.21	0.88	0.10	13.98
Newham University Hospital	0.20	2.64	0.40	0.27	25.87
St Bartholomew's	0.20	2.57	0.41	0.27	24.48
Whipps Cross	0.17	1.68	0.66	0.17	16.28
Royal London	0.18	2.17	0.50	0.23	20.26
job role					
Other (please specify)	0.17	1.14	0.77	0.48	2.68
Junior Doctor	0.37	6.16	0.00	2.09	18.12
Facilities Support Staff	0.21	1.87	0.41	0.42	8.44
Doctor/Consultant	0.19	1.59	0.39	0.56	4.55
Technical & healthcare support	0.18	1.34	0.59	0.46	3.86
Manager	0.12	0.49	0.16	0.18	1.34
Allied Healthcare Professional	0.17	1.15	0.70	0.58	2.27
Nurse	0.22	2.10	0.02	1.15	3.84
Admin & Clerical	0.16	1.00	baseline		

felt vending costs are too high					
characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.73		baseline		
night	0.91	4.00	0.00	2.13	7.53
work environment					
Other (please specify)	0.66	0.76	0.50	0.35	1.67
Out in the community	0.73	1.09	0.84	0.48	2.46
Office-based (not on a hospital site)	0.71	1.00	baseline		
Hospital-based	0.76	1.28	0.37	0.75	2.19
main worksite					
Other (please specify)	0.72	1.30	0.63	0.44	3.79
Prescot Street	0.67	1.00	baseline		
Mile End	0.59	0.69	0.39	0.30	1.61
Newham University Hospital	0.83	2.36	0.05	1.01	5.55
St Bartholomew's	0.77	1.62	0.24	0.72	3.65
Whipps Cross	0.66	0.95	0.91	0.43	2.10
Royal London	0.81	2.15	0.05	1.00	4.61
job role					
Other (please specify)	0.70	0.74	0.25	0.45	1.23
Junior Doctor	0.65	0.57	0.23	0.23	1.41
Facilities Support Staff	0.66	0.60	0.33	0.21	1.67
Doctor/Consultant	0.66	0.58	0.13	0.29	1.17
Technical & healthcare support	0.75	0.94	0.86	0.46	1.90
Manager	0.74	0.90	0.67	0.56	1.45
Allied Healthcare Professional	0.76	1.00	0.98	0.66	1.49

Nurse	0.77	1.07	0.74	0.71	1.62
Admin & Clerical	0.76	1.00	baseline		

felt café or canteen costs are too high					
characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.96		baseline		
night	0.96	1.09	0.86	0.39	3.05
work environment					
Other (please specify)	0.97	1.70	0.54	0.32	9.17
Out in the community	0.97	1.66	0.60	0.25	11.02
Office-based (not on a hospital site)	0.95	1.00	baseline		
Hospital-based	0.96	1.49	0.46	0.51	4.32
main worksite					
Other (please specify)	0.87	1.24	0.79	0.25	6.08
Prescot Street	0.84	1.00	baseline		
Mile End	0.96	4.47	0.06	0.94	21.22
Newham University Hospital	0.97	6.73	0.01	1.56	29.13
St Bartholomew's	0.95	3.54	0.06	0.96	13.13
Whipps Cross	0.98	8.56	0.00	2.03	36.05
Royal London	0.97	6.90	0.00	2.02	23.56
job role					
Other (please specify)	0.94	0.65	0.38	0.25	1.70
Junior Doctor	0.94	0.76	0.80	0.09	6.24
Facilities Support Staff	0.86	0.26	0.06	0.06	1.08
Doctor/Consultant	0.90	0.39	0.13	0.12	1.31
Technical & healthcare support	0.94	0.71	0.62	0.19	2.67
Manager	0.96	1.16	0.77	0.43	3.12
Allied Healthcare Professional	0.99	4.48	0.06	0.96	20.82
Nurse	0.97	1.43	0.47	0.54	3.78
Admin & Clerical	0.96	1.00	baseline		

used cafes or canteen a lot					
characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.80		baseline		
night	0.73	0.67	0.10	0.42	1.07
work environment					
Other (please specify)	0.76	1.48	0.36	0.65	3.38
Out in the community	0.81	2.14	0.10	0.86	5.35

Office-based (not on a hospital site)	0.68	1.00	baseline		
Hospital-based	0.80	1.99	0.01	1.16	3.41
main worksite					
Other (please specify)	0.47	0.81	0.70	0.28	2.36
Prescot Street	0.52	1.00	baseline		
Mile End	0.81	4.27	0.00	1.73	10.53
Newham University Hospital	0.87	6.42	0.00	2.64	15.65
St Bartholomew's	0.78	3.42	0.00	1.50	7.82
Whipps Cross	0.85	5.47	0.00	2.37	12.63
Royal London	0.78	3.58	0.00	1.65	7.76
job role					
Other (please specify)	0.74	1.05	0.85	0.62	1.80
Junior Doctor	0.95	8.11	0.04	1.07	61.47
Facilities Support Staff	0.80	1.45	0.55	0.43	4.89
Doctor/Consultant	0.84	2.05	0.11	0.86	4.89
Technical & healthcare support	0.82	1.66	0.19	0.78	3.56
Manager	0.87	2.67	0.00	1.49	4.77
Allied Healthcare Professional	0.77	1.20	0.40	0.78	1.85
Nurse	0.82	1.67	0.02	1.08	2.59
Admin & Clerical	0.74	1.00	baseline		

used retail external from the hospital a lot					
characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.73		baseline		
night	0.73	1.04	0.85	0.69	1.57
work environment					
Other (please specify)	0.66	0.57	0.20	0.24	1.35
Out in the community	0.73	0.80	0.64	0.33	1.99
Office-based (not on a hospital site)	0.77	1.00	baseline		
Hospital-based	0.73	0.78	0.41	0.44	1.40
main worksite					
Other (please specify)	0.83	0.11	0.06	0.01	1.06
Prescot Street	0.98	1.00	baseline		
Mile End	0.74	0.07	0.01	0.01	0.53
Newham University Hospital	0.58	0.03	0.00	0.00	0.25
St Bartholomew's	0.75	0.07	0.01	0.01	0.53
Whipps Cross	0.63	0.04	0.00	0.00	0.30
Royal London	0.79	0.09	0.02	0.01	0.67
job role					
Other (please specify)	0.66	0.81	0.40	0.50	1.32
Junior Doctor	0.85	2.54	0.07	0.92	7.04

Facilities Support Staff	0.85	2.46	0.17	0.67	8.96
Doctor/Consultant	0.74	1.20	0.61	0.60	2.41
Technical & healthcare support	0.74	1.20	0.61	0.60	2.38
Manager	0.72	1.09	0.71	0.68	1.77
Allied Healthcare Professional	0.79	1.60	0.03	1.06	2.41
Nurse	0.71	1.04	0.83	0.71	1.52
Admin & Clerical	0.70	1.00	baseline		

used vending a lot					
characteristics	proportion	OR	P-value	(95% CI)	
shift time					
day	0.19		baseline		
night	0.32	1.99	0.00	1.32	3.01
work environment					
Other (please specify)	0.20	1.31	0.64	0.42	4.13
Out in the community	0.24	1.69	0.39	0.51	5.62
Office-based (not on a hospital site)	0.16	1.00	baseline		
Hospital-based	0.22	1.50	0.30	0.70	3.26
main worksite					
Other (please specify)	0.14	0.83	0.83	0.16	4.45
Prescot Street	0.16	1.00	baseline		
Mile End	0.07	0.38	0.23	0.08	1.82
Newham University Hospital	0.21	1.38	0.63	0.37	5.12
St Bartholomew's	0.16	0.98	0.98	0.27	3.63
Whipps Cross	0.22	1.47	0.56	0.40	5.36
Royal London	0.27	1.90	0.32	0.54	6.64
job role					
Other (please specify)	0.21	1.22	0.52	0.66	2.26
Junior Doctor	0.14	0.75	0.59	0.26	2.13
Facilities Support Staff	0.34	2.44	0.10	0.86	6.95
Doctor/Consultant	0.26	1.63	0.20	0.78	3.42
Technical & healthcare support	0.34	2.53	0.01	1.28	5.02
Manager	0.12	0.61	0.16	0.31	1.22
Allied Healthcare Professional	0.21	1.21	0.78	0.75	1.96
Nurse	0.26	1.66	0.03	1.05	2.60
Admin & Clerical	0.18	1.00	baseline		